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IMPROVEMENTS IN METHODS OF STUDY OF STRUCTURAL GEOLOGY.

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The principles involved in representing the geology within any district, are difficult of presentation to students; in part because of the lack in many persons of a strong visualizing sense, but even more because the relation of the characters of the exposed rock surfaces to the conventional geological map is far from being a simple one. To make the work of the teacher less difficult, and the understanding of the subject by the student more complete, the writer has for a number of years made use of simple models representing the surface outcrops of rock and of a special table upon which to arrange them in the positions and attitudes which they assume in the field.¹ Experience has shown that students are greatly assisted by the use of these methods, but it has been found possible to reduce considerably the dimensions of the models while improving their mechanical construction, and, further, to replace the special table by a simple baseboard only three feet square, which when not in use may be set aside out of the way (see Fig. 1).²

In actual field studies it is necessary before the problems offered by Fig. 1 can be solved, to devote much time-consuming effort to fixing the position of each outcrop, determining its type (granite, sandstone, etc.), and if it is a sedimentary rock, measuring its dip and strike. In our laboratory studies through the use of numbered section lines upon the base, and by employing a small geologist's (clinometer) compass, these very necessary data are all secured and recorded in as many minutes as there would be days required for the actual field work. The representation upon the "field map," or map of observations, is carried out in exactly the same manner as when working in the field, a sec-

¹ Apparatus for Instruction in Geography and Structural Geology, III. The Interpretation of Geologic Maps, SCHOOL SCIENCE AND MATHEMATICS, Vol. 9, 1909, pp. 644-653.

² Manufactured by Eberbach & Son, Ann Arbor, Mich.

tioned base upon the township plan being especially provided for the purpose (Fig. 2). The conventional T symbols with thick-

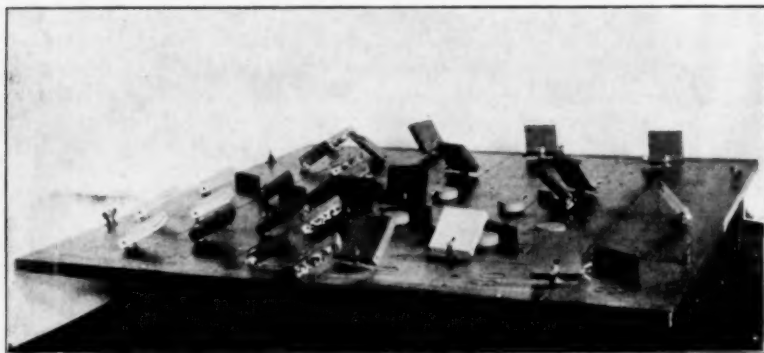


FIG. 1. Improved form of models to represent rock outcrops in their natural positions and attitudes, and the sectioned base upon which they are mounted. The drum-shaped blocks represent outcrops of igneous rock, the long and narrow blocks igneous rock when in the form of dikes, and the tilted blocks in different colors the various types of sedimentary rock. The attitudes of these latter blocks afford us the strike and dip, one edge of the baseboard being adjusted upon a north and south line.

Name _____

Legend		6	5	4	3	2	1
Sedimentary Rocks							
Igneous Rocks							
		7	8	9	10	11	12
		13	14	15	16	17	18
		19	20	21	22	23	24
		25	26	27	28	29	30
		31	32	33	34	35	36

Section _____
Section _____

FIG. 2. Special form of sectioned base on which the students' data are recorded.

ened heads permit the student to record upon his map of observations, not only the attitude of the sedimentary rock strata at each outcrop, but the kind of rock as well; a special legend at the side of the map affording the key to the color scheme adopted. In recording his observations, the figure representing the angle of the strike is placed at the one end of the top or head of the T, and that representing the dip at the end of the shank, the length of the shank being also so adjusted that long shanks represent flat dips and short ones dips nearer the vertical. Omitting these figures a student's field or outcrop map to represent the outcrops in Fig. 1, is supplied in Fig. 3.

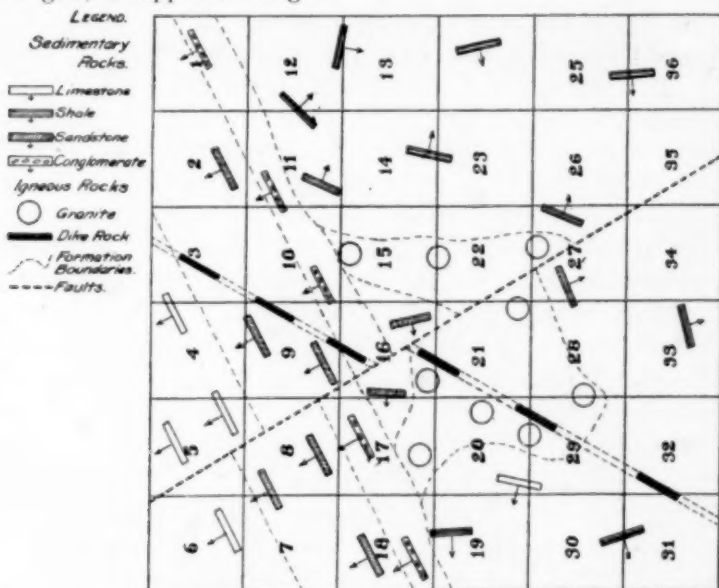


FIG. 3. Field map as prepared by the student from the assemblage of outcrops in Fig. 1. The inter-formational boundaries which are necessary in order to prepare the "areal," or final, map, have here been drawn in as dotted lines.

There are many things to be learned from this manner of study, which could be obtained in no other way than by long experience in the field; and it is of course to be assumed that all practice with map models is but an introduction to outdoor studies to be later undertaken. Not least important the student comes quickly to understand what a large measure of uncertainty is often involved in the drawing of formation boundaries. Referring to the map of Fig. 3, it will be readily appreciated that on sections 14, 15,

22, and 23 the dotted lines drawn may be in places incorrect by the width of a section; whereas upon sections 17 and 18 such error is obviously very much less, though large enough to make the experienced geologist sceptical concerning the accuracy of geological maps except as broadly interpreted.

There are, however, several facts of the first importance which come into prominence upon this map. The outcrops of sedimentary rock which appear in the left lower corner and extend over about one-third of the area of the map, are all essentially alike in their attitudes, and thus represent conditions of disturbance subsequent to their deposition which relative to the remaining portion of the area are notably simple. It is therefore clear that the rock strata within the large area have passed through vicissitudes in their history to which the less disturbed beds were not exposed. The further conclusion is that the less disturbed strata are the younger and are separated in time from the older formation by a long interval sufficient for the removal by erosion of the truncated upper portions of the older formations, the deposition of the younger strata and their subsequent elevation to where we find them—the two series of formations are separated by what in geology is termed an unconformity.

It is important that we learn the thickness of the rock strata within each series, and we will illustrate by beginning with those which are least disturbed. If a line be drawn upon the map perpendicular to the extension of the strata along the surface (their strike) we may from the angles of inclination (dips) of the beds construct a so-called geological profile (A B in Fig. 4), and from

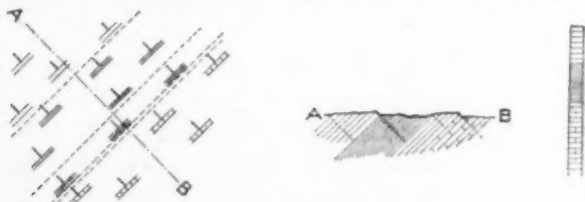


FIG. 4. Map, geological profile and corresponding vertical section of rock strata.

this in turn measure off a vertical section upon the assumption that the beds are restored to their originally horizontal positions. The thickness of each formation is obviously the width of its exposed area at the earth's surface multiplied by a simple factor derived from the angle of dip (the natural sine). It is evident that by this method we are able to measure the *full* thickness of formations

only when they are limited upon both sides by other formations which are exposed at the earth's surface.

To return to our field map (Fig. 3), we find two areas of igneous rock, namely: a granite occupying an irregular area, and a dike rock which takes its course in a long fissure. Of these igneous rocks the dike rock is the younger (latest to be formed), since the fissure within which it consolidated must have been opened through the already consolidated granite. A case where similar rocks are involved, but where the granite instead of being the older is the younger of the two, is shown upon the map of Fig. 5. If a

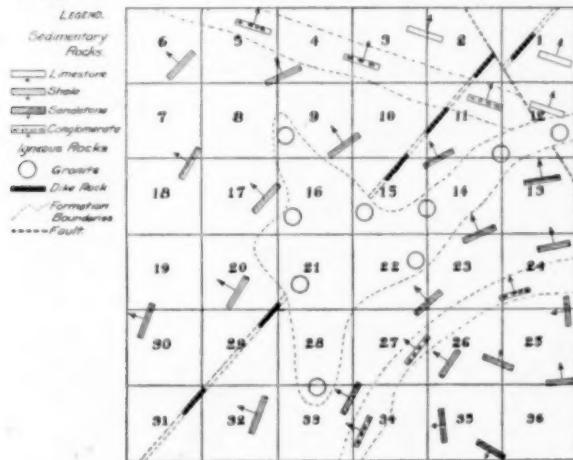


FIG. 5. Geological map to illustrate the positions of outcrops, their attitudes, and the possible boundaries between formations.

number of dikes of different ages had been present within the area, their order of relative age could have been determined in case they intersected, the intersecting dike of two being the younger. When dikes do not intersect, the same results can sometimes be obtained through the relations of the dikes to various sedimentary formations and the mutual relationships of the latter. In Fig. 6 there are represented three interesting dikes of igneous rock from which it is apparent that the order of age is 1, 2, 3.

Rock formations when disturbed from their original horizontal positions may be bent into flexures of folds, in which case they produce such attitudes within a group of outcrops as have already been referred to. If these folds are simple and thus represent only moderate amounts of disturbance, the group of outcrops may for

quite large areas of the map show almost identical dip and strike (conglomerate, sandstone and limestone in Fig. 3). If there has been large disturbance of the beds, marked differences in dip and strike between neighboring outcrops are apt to be revealed, and in passing from outcrop to outcrop the changes in strike appear as curves upon the map (shale in Fig. 3). It is characteristic of such differences in the attitudes of the strata at neighboring outcrops that they are progressive—indicate gradations.

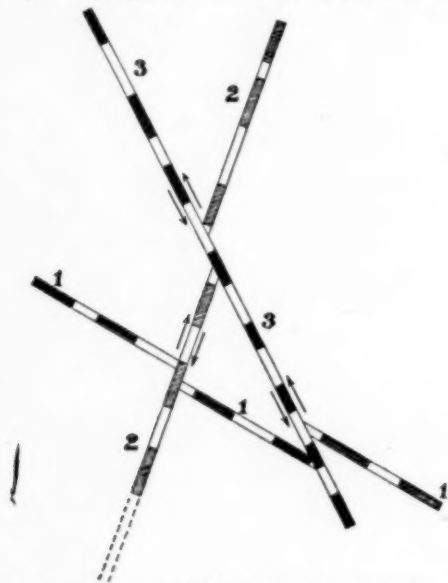


FIG. 6. Diagram map to illustrate the relative ages of three intersecting dikes of igneous rock. The order of intrusion (age) is 1, 2, 3. Here in addition to the formation of a fissure previous to intrusion by the molten rock material, some displacement (faulting) is represented to have taken place.

Where, on the other hand, the disturbance in the strata has resulted not in folding, but in fracturing and subsequent displacement (faulting) of the strata, the changes in dip and strike are abrupt and strictly local (note the attitudes of the outcrops on opposite sides of the straight dashed lines of Figs. 3 and 5).

The above are only a few of the usual geological problems which it is possible to discuss with the aid of the outcrop blocks so as to prepare the pupil to interpret correctly what he may see out of doors, where the complexity of Nature imposes upon us the duty of separating in our problems those facts which are pertinent from a host of others which for the time being are merely distracting.

A FALL APPARATUS FOR ELEMENTARY WORK.

BY A. P. CARMAN AND L. A. PINKNEY,
University of Illinois, Urbana.

The accelerated motion of a freely falling body is one of the most striking of universal physical occurrences, and yet it is one of the most difficult for direct and simple experiment. The greatest difficulty comes in the measurement of the small interval of time for practicable distances of fall. Yet this time interval must be measured with a considerable accuracy, for it comes into calculations as the squares.

To get around the measurement of these short times, we have devices for retarding the motion according to some definite law. The earliest of these devices is that of the inclined plane, which was used by Galileo in his epoch-making work in founding the science of dynamics. It is interesting to note that Galileo used the flow of water from a large tank as the most accurate method available for the measurement of small time intervals, the escapement clock not being invented until 1656, a half century later. (See Crew and de Salvio's translation of Galileo's *Two New Sciences*, page 179.)

The second device for producing retarded falling motion is that invented in 1784 by the Cambridge University professor, George Atwood. The famous "Atwood's machine," in various ingenious forms, has played a big role in elementary instruction in physics for over a century and a quarter. One thing that can be said for it, is that the student who understands the Atwood's machine has clear conceptions of mass, momentum and force, and also knows something about errors in physical apparatus.

The fact that both the inclined plane and the Atwood's machine call for extra conceptions and difficult corrections, has led in recent years to the development of devices for the direct measurement of the time of a freely falling body. It is obvious that such a direct method of experimenting has decided advantages for elementary instruction if a fair degree of accuracy can be reached. An examination of elementary laboratory manuals of physics, and of the two standard journals for teaching physics, *School Science* and the *Zeitschrift für Physikalischen und Chemischen Unterricht*, shows a score or more of recent pieces of apparatus for getting directly the time of a freely falling body.

The following is an account of a piece of apparatus of this kind which we have developed during the last two years. It is

evidently modeled on a well known previous form of fall apparatus, but contains two or three new and essential features which experiments show contribute greatly to accuracy and convenience.

The apparatus is shown in the accompanying figure (Fig. 1). A vertical steel rod about 1.5 meters high is fitted with a clamp at A to support the knife edges of a pendulum. The lead ball M which is to be released for free fall, is hung by a fine thread to a small piece of fine fuse-wire which is stretched horizontally across two binding posts in a hard rubber fork held on the clamp B. The

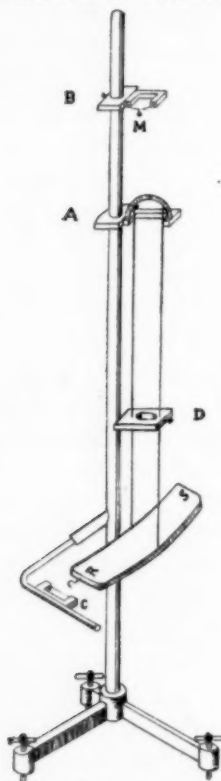


FIG. 1.

pendulum is about 80 centimeters long and consists of two rods attached below to RS a rectangular block of wood which forms the "bob." The upper ends of the rods are attached to the knife edge yoke. The pendulum is held in its position of maximum displacement by a small hook which is caught over the fuse which is stretched horizontally across an insulating fork. The two pieces of fuse wire can be connected simultaneously into a 110 volt electric circuit by a single switch. The 110 volt electric circuit

is that of the lighting system of the building, connection being made to a lamp socket by an attachment plug. The fuses were sometimes connected in parallel and sometimes in series. With these small equal fuse wires, and with the high voltage, the fuses appear to "blow" instantaneously. We found that both fuses "blew" when in series and so have generally used this connection, for it seemed to insure that the releases of the ball and of the pendulum must take place almost if not actually at the same instant.

The point where the ball M strikes the swinging block RS of the pendulum is fixed by the well known device of placing a piece of carbon paper over a piece of white paper which is laid on RS. This block is cylindrical, the axis being the line of the knife edges of the pendulum. In adjusting the apparatus, the ball M is hung in place so that it strikes at the middle of the block RS, when the pendulum is at rest. If the ball strikes the "middle line" when the pendulum and the ball are released simultaneously, it is evident that " t " the time of the fall is equal to the quarter period of the pendulum. The period T of the pendulum can of course be gotten with a high accuracy, and thus t can be measured. Then measuring h the distance of the fall, we calculate " g " directly by using the formula $h = \frac{1}{2}gt^2$. To get the time of fall equal to the quarter period of the pendulum, requires in general that either (a) the height h be changed, or (b) that the period T of the pendulum be changed. The height h can be changed by raising or lowering the support A. The period of the pendulum can be changed by raising or lowering the adjustable mass D which is clamped across the pendulum rods.

This adjustment of h and T though not particularly tedious requires some patience. An approximate adjustment is however quickly made, and is all that is necessary, for if the distance of the impact of the falling ball from the "middle line" is small, the calculation of the time of fall is very simply made. Suppose the pendulum moves from right to left, and the impact point is a distance x to the *right* of the middle line. Then the time of fall t is a quarter period, *plus* the time that it takes to move the distance x in its path. If the distance x is to the *left* of the middle line, then z is to be subtracted from the quarter period $T/4$ to get the time of fall. The time z for small values of x is then equal to $\frac{xT}{2\pi r}$, where r is the amplitude or maximum displacement of the swinging pendulum and T as above is the period. The total time of fall is then $t = \frac{T}{4} \pm \frac{xT}{2\pi r}$. To prove the above, we consider

the pendulum motion as the projection upon a diameter of the uniform motion of a point about the circle. (Fig. 2). That is, the motion of c on the diameter $a'o'b'$ is the same as that of the pendulum if c' is the foot of the perpendicular let fall from a point P which moves about the circle in the period T .

Using this definition of an ideal pendulum motion, we can get directly the time z that the pendulum takes to move the short distance $x = o'c'$. The time z is evidently the time that P moves through the arc PN . As P moves through the whole circumference $2\pi r$ in time T , by simple ratio we get the time z for the arc PN , as $z = PN \frac{T}{2\pi r}$.

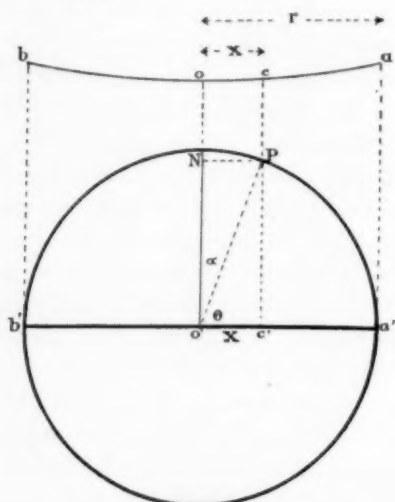


FIG 2.

For large values of x , it is necessary to use a trigonometric formula to get the corrected time. This can be shown to be $z = \arcsin x/r \frac{T}{360^\circ}$. If this corrected time is to be used, precision determinations of h and T are of course desirable.

After a number of experiments to determine the best proportions, the following dimensions were found satisfactory; length of pendulum 105 cm., height of fall h varied from 105 cm. to 125 cm., starting displacement R of the pendulum about 6 cm., diameter of lead ball 1.5 cm. A typical set of six successive determinations gave an average value of " g " of 981.5 cm. per sec. per sec. with extreme values of 978 and 985, that is with variations of less than a half of one per cent from the mean. In measuring the period and the distance, a stop watch and a meter bar, such as

are available in an ordinary elementary laboratory, were used, since the purpose of the method was not to make a precision determination of "g," but to get a simple and practical method of getting uniformly good approximate values of "g." By using a chronometer for measuring the period, and a cathetometer for determining the height, it seems certain that this apparatus could be made to give values of "g" fully as uniform and good as the elaborate magnetic release apparatus of Edelman, and that may be attempted later.

WHAT BAD EYES MAY MEAN TO A NATION.

Many people think but little of the consequences of bad eyes, unless blindness, or very sore eyes are threatened or present. Such conditions are terrible, but they do not threaten the people or state as much as other eye diseases that are not apparently pitiable.

People who are blind or whose eyes are hopelessly diseased are usually taken care of in institutions and do not become a menace to the public. But school-children whose eyes look all right, but who have certain diseases or defects that render study and education a hardship, may become a danger to other people. A schoolchild, born with an undetected cataract, or very near-sighted, so that he cannot see the blackboard, soon falls behind his class and becomes discouraged with his school-life. A child with far-sight, or astigmatism, or some muscular defect of the eyes, by which when he studies his eyes pain and he suffers from headache will contract a dislike for books, study and education, and will perhaps be punished or kept after school for something for which he is really not to blame. Such children, their educational progress embarrassed or almost stopped by reason of uncorrected physical defects, soon acquire a loathing for education and all that education represents, and, the seeds of idleness and irresponsibility being sown, may develop into criminals and dependents. No flight of fancy is required to transform such children into the non-supporting "ne-er do well," the wandering and menacing tramp, or the idle pleasure-seeking and misery-finding prostitute. Bad eyes that hinder education mean a distaste for school. Idleness, truancy, bad associates and habits, drinking, gambling, stealing, murder, prison and the gallows may follow. This is no fancy picture. It can be proved by observation and statistics. Visit the criminal courts, the reformatories, the jails and prisons, and how often do you find lawbreakers from the ranks of the educated. Some, it is true, are natural criminals, the offspring of criminal parents, but even here there must have been a beginning, proceeding some generations back, perhaps from some ancestor who was deprived of proper training, education, possibly by bad eyes. The great mass of criminals, however, are not born offenders, but become so through associations and lack of a cultivating and ennobling education, which is, of course, practically impossible if bad eyes or other defects prevent a suitable education. Education is one of the greatest barriers to crime and poverty. It is therefore essential that our children, the coming generation, should be well educated, and that bad eyes, or any other physical or mental defects, should be detected and corrected, in order that the acquirement of an education may become as easy and agreeable as possible.

MAGNETIC PHENOMENA.

BY S. R. WILLIAMS,
Oberlin College, Ohio.

It is a question whether a shepherd named Magnes once lived and led his flocks over the slopes of Mount Ida. It is still more questionable that, while engaged in this honorable calling, he noticed that the iron ferrule of his staff was attracted by the rocks of the mountain. This fact remains, however, that it is a pretty legend of the way in which the word magnetism came into being and at least points out that from very ancient days down to the present there has been a great human interest in the phenomena associated with magnetic fields.

Each year scores and scores of investigations² bearing on magnetic phenomena are published in the various scientific and pseudo-scientific periodicals of the world, but in spite of all of this accumulation of knowledge, we are almost forced to a conclusion concerning the twentieth century, which Helmholtz drew concerning the nineteenth when he was credited with having said that the ignorance of the subject of magnetism was the disgrace of the nineteenth century.

It is not, therefore, in the hope of bringing coals to Newcastle that I wish to speak on this subject this afternoon but rather to accomplish what Professor Lummer of the University of Breslau once suggested in his non-resident lectures at Columbia University, "If you wish to know something about a particular subject, write a book or give a course of lectures on it." It is at once evident that the subject of the paper is a broad one. In it an attempt has been made to see if the various magnetic phenomena we now know could be tabulated and so correlated that we might get a better birdseye view of the subject. An effort has also been made to show where there might be a good point of attack for finding out more in regard to the general subject of magnetic phenomena.

In the first place all magnetic phenomena demand the existence of a magnetic field and hence we may make a general summary and say that all magnetic phenomena are the effects of magnetic fields. Hence in the following list the various magnetic phenomena are classified as effects with the subjects that may be considered under these various heads as sub-divisions.

¹Read before the Physics and Chemistry Section of The North-Eastern Ohio Teachers' Association, held in Cleveland, Ohio, October 23, 1914.

²Knowlton, *Ter. Mag.*, p. 3, Vol. 15, 1900.

	I. Induction Effects	<ul style="list-style-type: none"> Magnitude of Induction. Para, Dia and Ferromagnetism. Permeability, Susceptibility, Coercive Force and Retentivity. Permanent and Residual Magnetism. Terrestrial Magnetism. Alternating Currents. Inductive Effects as influenced by Heat, Mechanical Strains, Aging, etc. Villari Effect.
II. Mechanical Effects.	(a) Reaction effects between Magnetic Fields	<ul style="list-style-type: none"> Attraction and Repulsion of Magnetic Poles. Motion of Electric Conductors or of Currents, whether in a Solid, Liquid or Gaseous Conductor, when placed in a magnetic field. Hall Effect and its Reciprocal Relations. Change in Resistance due to a Magnetic Field. Effect on Thermo-electric phenomena. Production of Chemical Changes.
	(b) Magnetostrictive Effects	<ul style="list-style-type: none"> Change in Length due to a Magnetic Field, (Joule Effect). Its Reciprocal Relations. Wiedemann Effect. Its Reciprocal Relations. Volume Change. Its Reciprocal Relations. Production of Sound. Piezo- and Pyro-magnetism. Magne Crystalline Action.
	III. Magneto-optical Effects	<ul style="list-style-type: none"> Faraday Effect. Kerr Effect. Zeemann Effect. Magnetic Double Refraction.

From this classification it would seem that all magnetic phenomena might be placed in three compartments. Of course there is overlapping and to discuss the reasons why a certain effect is pigeonholed as it is, is beyond the scope of this paper in the time allowed. Suffice it, at this point, to say that the Zeemann, Faraday and Kerr magneto-optical effects might have been put in class IIa since we explain the phenomena from the standpoint of the effects produced on the orbits of the electrons in the atoms by a magnetic field altering the periods of vibration, and, if we think of the inductive effects in class I as being influenced by the rotation of the elementary magnets we see how predominant is the idea of mechanical effects in all of the phenomena.

We may next turn to the question proposed in the beginning and attempt to show where these diversified magnetic phenomena may be further correlated. While theory and experiment should go hand in hand it is evident that what we need here more than

anything else is knowledge obtained by experiment. A great many theories³ have been proposed and have been of great value in suggesting new lines of research but so far none of them gives a satisfactory reason for all of the phenomena met with.

To look at the catalog of magnetic phenomena once more it may be well to point out that the Faraday and Kerr effects are frequently used⁴ in measuring the amount of magnetic induction as also are some of the reactions in class II,a. That is, classes I, II,a and III have been very thoroughly studied with respect to each other. The relation of class II,b to the other sub-divisions, however, have not been so elaborately studied and it is here, apparently, that a good starting point in the pursuit of more knowledge of our subject may be had. Some work⁵ which has been done along this line has been very encouraging.

The magnetostrictive effects are those in which we find reciprocal relations between the magnetic properties and the changes in dimensions, i. e., if a piece of ferromagnetic substance is magnetized it will change its dimensions and contrariwise a mechanical change in the dimensions of the same specimen produces changes in the magnetic qualities of the substance. Usually the phenomena in class II,b have been studied in one set of specimens and these results compared with the results obtained from other specimens in measuring other phenomena. I think we must now insist that all comparative work shall be done on the same specimens. There has been very little work of this sort done. Now without going into the reasons why, it may be stated here that all of the magnetostrictive effects mentioned in class II,b may be shown to be special cases or reciprocal relations of the Joule effect. Our study may therefore be limited to a comparison of the Joule effect with the phenomena listed in classes I, IIa, and III.

The Joule effect may be described as a change in length due to a magnetic field. If a rod of iron, for instance, is magnetized longitudinally and in so doing the magnetizing field is increased from zero upward, the rod, in general, will first increase its length and then decrease until it is shorter than in its virgin state. See Fig. 1. On a collection of steel, nickel and nickel-steel alloy rods, comparative tests⁶ between the Joule effect and other mag-

³These theories are well reviewed in Campbell's "Modern Electrical Theory," Chap. IV., p. 73.

⁴DuBois, Phil. Mag., 20, p. 293, 1890.

⁵Phys. Rev., Vol. 34, Jan. 1912, April 1912, Vol. 35, Oct. 1912. Vol. 2, N. S. Sept., 1913, Vol. 1914.

⁶Bidwell, Proc. Roy. Soc., 1886-1890.

netic phenomena have recently been carried out. For instance, a comparative study was made of the Joule effect and the magnetic induction in the same specimens of steel rods. The Joule effect was measured as follows: a solenoid 100 cm. long and

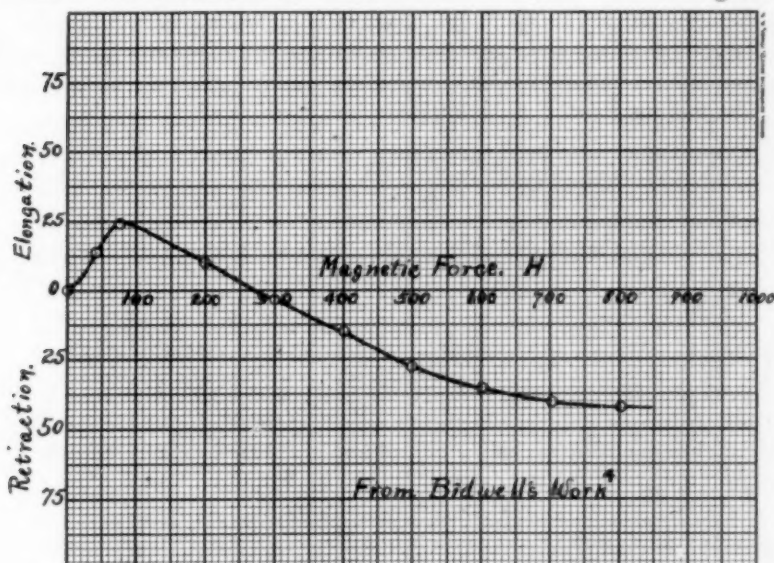


FIG. 1. Change in length of iron due to magnetization, change expressed in ten millionths of the length.

over 6000 turns, was mounted in a vertical position and the rod placed along the axis of the same⁷. The upper end of the rod was clamped securely while the lower end actuated a mirror for an optical lever in order that the effect of change in length might be



FIG. 2.

multiplied. As the mirror was tipped a spot of light reflected from it made a continuous record of the amount of elongation on a photographic film as the magnetic field was varied. In Fig. 2

⁷Phys. Rev. Vol. 34, p. 260, 1912.

are shown graphs for three different specimens of steel. The vertical lines represent known values of magnetic field strength, knowing the magnifying power of the optical lever the amount of elongation for each field may be determined. Next the magnetic induction of the same specimen was determined by the method of reversals. The Joule effect and the magnetic induction were then plotted for the same field strengths. This is shown in Fig. 3.

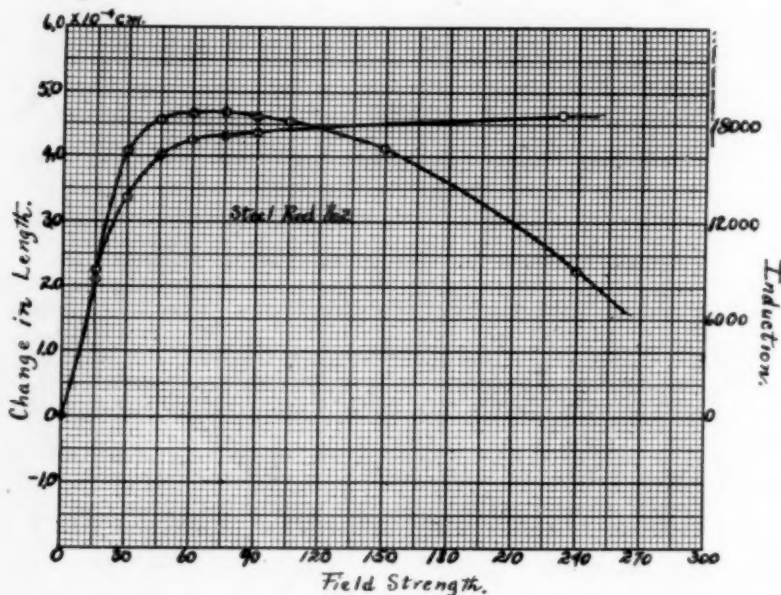


FIG. 3.

The striking and, as it seems to me, important relations here are that the maximum elongation of the rod occurs at about the same field strength as that at which the third stage, as Ewing calls it, occurs in the induction curve, and also the most rapid rate at which the elongation occurs, appears at the same field strength as that of the most rapid change in the induction. A theory of magnetism must therefore harmonize a mechanical effect with a straight induction effect.

Again, the Joule effect has been compared with the so-called Villari⁸ effect. In this latter phenomenon it has been found that if an iron rod is subjected to a pull that the induction is thereby increased for weak field strengths and decreased for strong. For weak magnetic fields, as we have seen, there is an increase in length for the Joule effect in iron and a decrease for strong. The theoretical physicists have been telling us for a great many years

that this is what we should expect from the reciprocal relations between magnetism and the elastic constants of ferromagnetic substances. May we now have some mechanical model showing us why this is true, for we have here two mechanical effects to explain and a mechanistic theory of magnetism must be forthcoming.

We might thus go on describing other effects which have been compared with the Joule effect, but these are sufficient to show that here we are touching upon some vital relations in the field of magnetic phenomena and only when our knowledge of these relations shall have increased may we hope to have a more unified view of what is an exceedingly interesting field of research, the lure of which may be as attractive as that of an El Dorado.

⁸Phys. Rev. Vol. 4, p. 288, 1914.

DRYING GRAIN BY ELECTRICITY.

At some mills grain is being dried by electricity. The heating devices are installed in the casing inclosing the spiral screw that conveys the grain from the storage bins to the stones, and the grain is thus thoroughly dried immediately before it is ground. This drying is reported to make the grinding easier and to also insure a better and more uniform quality of the product of the mill.

THE SPECTRUM EXTENDED IN EXTREME ULTRA-VIOLET.

The researches of Schumann enabled him to extend the spectrum to about $\lambda 1250$, and subsequently Mr. T. Lyman continued it to $\lambda 1030$ by the use of a concave grating. Now Mr. Lyman has succeeded in photographing the spectrum of hydrogen to $\lambda 905$. It is characteristic of the region investigated by Schumann between $\lambda 1850$ and $\lambda 1250$ that, while hydrogen yields a rich secondary spectrum, with the possible exception of one line, no radiation has been discovered belonging to the primary spectrum. On the other hand, in the new region between the limit set by fluorite and $\lambda 905$, a disruptive discharge in hydrogen produces a primary spectrum of great interest, made up of perhaps a dozen lines. These lines are always accompanied in pure hydrogen by members of the secondary spectrum, but they may be obtained alone if helium containing a trace of hydrogen is employed. Results obtained from vacuum tubes when a strong disruptive discharge is used must always be interpreted with caution, since the material torn from the tube itself sometimes furnishes impurities. In the present case, it will be some time before the effect of such impurities can be estimated. However, it may be stated with some degree of certainty that the diffuse series predicted in this region by Ritz has been discovered. The first member at $\lambda 1216$ is found to be greatly intensified by the disruptive discharge, and the next line at $\lambda 1026$ appears also, though very faintly. This diffuse series bears a simple relation to Balmer's formula. Following the same kind of argument, a sharp series corresponding to the Pickering series might be expected. The new region appears to yield two lines belonging to such a relation at the positions demanded by calculation.—*Scientific American*.

A WATER BAROMETER.

BY JOHN C. PACKARD,
High School, Brookline, Mass.

Our latest novelty is a homemade water barometer that extends from the third floor of the High School building down the stair-well to the basement and rises and falls by startling amounts in response to slight changes in barometric pressure.

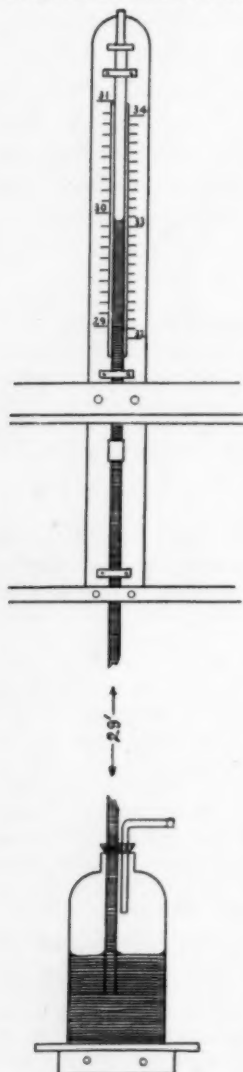
The tube is of glass; it was built up in sections from 5 ft. lengths of $\frac{1}{4}$ in. tubing borrowed from the chemical laboratory and jointed with short pieces of heavy wall black rubber tubing. The joints were made air tight by the application of a small quantity of vaseline around the edges of the rubber; a glass stopcock was sealed to the upper end.

The reservoir consists of a two-quart bottle fitted with a two-hole rubber stopper. Through one of the holes extends the end of the barometer tube and through the other a short piece of glass tubing to the outer end of which is attached a rubber tube.

The scale is double. On the right hand side of the wooden frame that supports the upper end of the barometer tube above the stair rail, is a paper scale marked 32, 33, 34, indicating the height in feet above the water in the reservoir below, and divided into inches: on the left is a similar scale giving the equivalent readings of the mercury barometer (suitable corrections having been made for the tension of aqueous vapor at a temperature of 68° F.).

The barometer was filled as follows: The reservoir was filled $\frac{3}{4}$ full with clear water; an aspirator screwed to a faucet at the sink in the Physical Laboratory

was attached by a piece of heavy wall rubber tubing to the top of the barometer tube, and the air exhausted as completely as



possible; an assistant then applied his lips to the open end of the rubber tubing at the reservoir below and by the pressure of his own lungs forced the water column above the stopcock at the top of the tube; the instructor immediately closed the stopcock and the assistant released his pressure at the reservoir; the water column fell at once to the barometric height and remained at that point.

Air came up at first in large quantities but after two or three trials in which care was taken to apply the exhaust before opening the stopcock, in order that the water column might not fall between times, the air was found to be practically all out and the barometer ready for business. It was found advisable after a time to substitute $\frac{1}{2}$ in. tubing for the upper two lengths to avoid the extension of the air bubbles across the water column. The barometer has worked well since then and has proved an interesting and valuable addition to our equipment.

GRANITE QUARRIED FROM BOWLERS.

An interesting feature of the production of granite in California is the quantity of stone quarried from large residual boulders. These boulders, according to the United States Geological Survey, represent the remnants left from prolonged disintegration of large granite masses, but after a thin weathered coating is removed they yield sound stone. Good granite should stand a crushing strain of at least 20,000 pounds to the square inch; some granites will stand 40,000 pounds. This may be compared to common red brick, which will crush at about 3,000 pounds to the square inch.

MOST VIOLENT ERUPTIONS VIEWED WITH SAFETY.

Mauna Loa and Kilauea are in many respects abnormal volcanoes. The most notable feature is the singular quietness of their eruptions. Rarely are these events attended by any of that extremely explosive action which is characteristic of nearly all other volcanoes. Only once or twice within the historic period have they been accompanied by earthquakes or subterranean rumblings. The vast jets of steam blown miles high, hurling stones, cinders, and lapilli far and wide, filling the heavens with vapor and smoke, and hailing down ashes and fragments over the surrounding regions, have never been observed here. Some action of this sort is indeed represented, but only in a feeble way. The lava wells forth like water from a hot, bubbling spring, but so mild are the explosive forces that the observer may stand to the windward of the grandest eruption, so near the source that the heat will make his face tingle, yet without danger. Ordinarily the outbreak takes place without warning and without the knowledge of the inhabitants, who first become aware of it at nightfall, when the sky is aglow and the fiery fountains are seen playing. As the news spreads, hundreds of people flock to witness the sublime spectacle, displaying almost as much eagerness to approach the scene of an eruption as the people of other countries show to get away from one.

PHOTOGRAPHY IN HIGH SCHOOL CHEMISTRY.

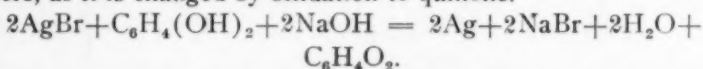
BY HARRY CLIFFORD DOANE,

Central High School, Grand Rapids, Mich.

It is customary for high school textbooks to devote a few paragraphs to photography and I have found rather complete demonstration, given when assigning the lesson on this subject, to be productive of good results. A camera, preferably one using plates, should be at hand and the formation of the image through a pin-hole and by means of the lens should be simply explained. This will not be necessary, of course, when physics has preceded the chemistry course. If a camera is not a part of the lecture room equipment, a boy who possesses one can always be found in the class.

After showing the camera I make an exposure and then develop and fix the plate before the class, explaining carefully the chemical reactions. Fortunately my lecture room can be sufficiently darkened to be successfully used as a dark room. One who has not tried it will be surprised at how much light can be in the room and still not spoil the demonstration, as some fogging does not prevent the viewing of the formation of the image.

While the products of the reaction with many of the developers are not known, the result always depends upon a reducing action and hydroquinone can nicely be used as an example of developers, as it is changed by oxidation to quinone.



It is well to notice that it is not the silver salt that is reduced. It helps to a clear understanding of the action of the developer and of the fixing agent to pass about the class an unexposed plate, then to develop half of it and fix it.

For some reason, rather hard to understand, our textbooks in elementary chemistry usually make no reference to the gaslight papers, although these are the ones used most commonly, the silver bromide papers being seldom used except for enlargements. The gaslight papers are coated with an emulsion containing silver chlorid, sometimes alone and sometimes along with some silver bromide, although the elementary pupil, and perhaps the chemistry teacher, would naturally conclude, from reading the usual textbook, that gaslight papers are silver bromide papers. I know that such was the case with myself until I made a special study of photography.

The detailed directions that I use in the laboratory follow:

A. DEVELOPING-OUT PAPER.

1. In a very subdued light place in a printing frame a negative and a piece of gaslight paper with the sensitized side of the paper against the film side of the negative. (Sensitized side of the paper is the concave side, as the paper curls.) (1) With what was the plate coated before being exposed in the camera? (2) With what is the paper coated?

2. Place the printing frame in front of an electric light bulb, at a distance of 7 inches (not less than the diagonal of the negative) and so that the light will strike equally on all parts of the negative. Turn on the light for four to six seconds.

3. Turn out the light, remove paper from the frame and examine. Result?

KEEP THE HANDS DRY. WATER OR CHEMICALS MUST NOT TOUCH EITHER THE NEGATIVE OR THE PRINT, EXCEPT AT THE PROPER TIMES.

DO NOT ALLOW A DROP OF ONE CHEMICAL SOLUTION TO BE TRANSFERRED TO THE OTHER TRAY.

4. Place the paper in the developer with the coated side up, putting one end into the developer and *quickly* sliding the paper into the tray so that it is completely covered. If the image appears in less than two seconds it usually indicates over exposure, and if it does not appear for six seconds, it indicates under exposure. Do not hold the print in the fingers while in the developer. Stains will result. (1) Result? The developer contains metol, hydroquinone and Na_2CO_3 . The Na_2CO_3 hydrolyzes producing NaOH . (2) Equation? (3) As all developers act similarly to hydroquinone, write equation for its action here. (4) Of what is the image formed? (5) What essential property have all developers?

5. As soon as the image is sufficiently clear remove from the developer and rinse in the sink. The image should fully develop in not less than twenty nor more than thirty seconds. If left in the developer more than thirty seconds the print is liable to be stained.

6. Place the developed print face up in the fixing solution completely covered, move about for a minute or two at first and leave for about fifteen minutes, being careful, when several prints are in the tray, that they do not mat together. (1) What substance is in the fixing solution? (2) How does it act? (3) Equation?

7. After removing the print from the fixing bath allow to re-

main for thirty minutes in running water in the sink to thoroughly remove the remaining chemicals.

8. The print may be laid upon a piece of paper, face up, to dry.

B. PRINTING-OUT PAPER.

1. Repeat A 1 using printing-out paper. With what is the paper coated?

2. Place the printing frame in the sunlight, occasionally examining the print by opening one-half of the back of the frame *shielded from bright light*. Print until the color is decidedly deeper than desired in finished picture. Result?

3. Remove print from frame and wash by allowing it to remain fifteen minutes in running water in the sink.

4. Place the print in a toning solution of gold chlorid, allowing it to remain until of a satisfactory shade, *keeping it in constant motion*. (1) Explain the action. (2) Equation?

5. Remove print from toning solution and rinse well in the sink.

6-8. Repeat A 6, 7, 8.

NEW YORK STATE USES MUCH NATURAL GAS.

The year 1912 surpassed all previous years in the quantity and value of natural gas produced in New York, while large volumes were also imported from Pennsylvania.

The total quantity of gas produced in New York in 1912 is estimated by E. W. Parker, of the United States Geological Survey, at 8,625,979,000 cubic feet, valued at \$2,343,379. On the other hand, the consumption of gas in New York during the year was 16,927,598,000 cubic feet, valued at \$4,866,821, an average price of 28.75 cents a thousand cubic feet.

Late in 1911 an excitement was created by the discovery of gas in the neighborhood of Orchard Park, where at a depth of 1,625 to 1,675 feet gas wells with a pressure of 250 to 625 pounds were brought in. Several companies were organized to exploit this territory, with most encouraging results. During the year 1912 out of a total of 78 wells completed in Erie County only 11 were dry holes. These gas wells range in depth from 1,600 to 1,900 feet and have a rock pressure of 135 to 950 pounds. These new wells have materially increased the gas production of the State.

The larger proportion of the gas consumed in New York is consumed for domestic purposes, the estimated amount so used being 15,329,811,000 cubic feet, valued at \$4,583,414, an average price of 29.90 cents a thousand cubic feet. Only 1,597,787,000 cubic feet, valued at \$283,407, was consumed in the industries.

The difference between the value of the gas consumed in New York and the value of gas produced in New York, which in 1912 amounted to \$2,523,442, represents the amount received for gas piped into this State from Pennsylvania.

THE CORRELATION OF HIGH SCHOOL AND COLLEGE CHEMISTRY¹

BY JAMES BROWN,
Butler College.

This subject I submit for consideration, not as one who has anything final to offer, but as a teacher who has considered several different systems and has tried some of them.

Inasmuch as the objects sought in the various high schools and college courses differ, it is difficult or impossible to devise any system of correlation which will suit all cases with the maximum of efficiency. Local conditions and previous training of students, as well as the future plans of the students, so far as these are definite, must be determining factors. In any case efficiency, rather than convenience, should be our guide.

In considering this question, I have found it convenient to propose three alternatives for students who have completed a high school course in chemistry and elect to continue the subject in college. The alternatives are as follows: First—To admit the student at once to second year chemistry, usually qualitative analysis. Second—To give the student the same course as those who have had no previous work in chemistry. Third—To give to such students a special course in general chemistry.

The first alternative—To admit the student at once to second year chemistry I do not favor for theoretical reasons and because my experience has found it unsatisfactory. In this case you have high school students, the nature of whose courses in chemistry has differed widely, subjected to the same prescription as college students whose courses have usually been more uniform and deeper. This is apt to be especially true because the college recitations and laboratory periods are usually longer and because in a great many college courses in general chemistry more or less qualitative analysis is introduced. This enables the college student to start qualitative analysis at a somewhat advanced point.

On the theoretical side we find similar differences. The time is past, if it ever did really exist, when a course in qualitative analysis conducted in a mechanical way, may be considered properly taught. The theory of the subject is presented in our best text books from the point of view of ionic equilibrium, the periodic system, and the electro-chemical series. Our best college text-books and laboratory manuals in general chemistry emphasize these

¹ Read before the Indiana Academy of Science, December, 1914.

same subjects. This, it seems to me, gives the correlation between general chemistry and qualitative analysis which is not secured by courses which do not place emphasis on these three subjects. Equations also must be well learned throughout all chemistry courses. We must not, to be sure, give too much time to equations to the exclusion of other parts of the science. But have you ever known a good chemistry student who could not write equations? I often wonder if equations are being neglected.

The second alternative—To put all students into the same course in general chemistry admits of several interpretations. Shall we give full credit for the course to the student who has received an entrance credit in chemistry? This may mean duplication of credit. Such duplication exists in one form or another in some subjects. Shall we do the same in chemistry? This question is variously answered by different institutions.

Duplication of credit may be avoided by requiring different laboratory experiments and different written work in the laboratory and in connection with the textbooks, from the two classes of students. This is rendered difficult by the different contents of the High School courses. Or we may avoid this duplication by giving only part credit for the college work to those who have entrance credit in chemistry. This may appear to the student to be work without credit, and is often opposed on those grounds.

The third alternative—To give a different course to the two classes of students, may be accepted in different forms. In some cases students have totally omitted the first part of the course, and taken the latter part entire. This I think is objectionable because of sins of omission and commission. The student should have much of what he omits in the first part, and duplicates much that is familiar to him in the second part. We may on the other hand give a shorter course covering the whole subject to our students with entrance credit, avoiding duplication of work which may be supposed to be familiar, and giving only what we think will impart the advanced point of view which we consider advisable.

This accomplishes in another way much the same end as the plan of assigning different work under the second alternative. These two plans are subject to the same difficulty. The students have had quite different courses in High School and do not well admit of the same diagnosis.

Will not a satisfactory solution of our problem be accomplished by the introduction into our High Schools of the new courses in

General Science now being advocated? This would leave the specialization along different branches of science in the hands of the Colleges and would enable us to treat all classes of students alike without fear of duplicating credit, or of omitting anything essential. Probably our high school science should be conducted with the purpose mainly of enabling the student to interpret his daily environment. In college, however, while considering fully the interest of the student whose object in chemistry is cultural, we must be guided mainly by the professional student and by those who, for various reasons, wish to specialize in chemistry.

ILLUSTRATIVE MATERIAL FOR BIOLOGY CLASSES.¹

BY HAROLD F. SHANN.

BOTANICAL.

- Corn Products Co., Chicago—Pamphlets and commercial products.
 Washburn Crosby Co., Minneapolis, Minn.—“Simplified Flour Mill,” a large chart; excellent.
 Quaker Oats Co., Fort Dodge, Iowa—24 bottles of cereals.
 Henry A. Dreer, Philadelphia, Pa.—Seed Catalog; very fine.
 Postum Cereal Co., Battle Creek, Mich.—School exhibit of Grape Nuts, Postum and Post Toasties.
 American Manufacturers Assn., 1236 First Nat. Bank Bldg., Chicago, Ill.—Manufacture of Corn Products, booklet.
 Bulletins of U. S. Dept. of Agriculture, of State Experiment Station, and of International Harvester Company, Chicago—Lists furnished upon application.
 Pillsbury Co., Minneapolis²—12 samples, 18 lbs. F. O. B.

ZOOLOGICAL.

- L. E. Hildebrand, New Trier High School Kenilworth, Ill.—Living Hydra, 50¢-\$1.00.
 North Star Woolen Mills Co., Minneapolis, Minn.—Small exhibit of wool, yarn, and blanket material.
 American Woolen Co., Boston, Mass.—From Wool to Cloth, booklet.
 Cheeney Silk Mfg. Co., Manchester, Conn.; Eureka Silk Mfg. Co., New York, N. Y.—Silk: Educational exhibit.
 Belding Bros., Belding, Mich.—Silk Culture and Its Manufacture, 25¢; a very well illustrated book.
 T. A. Kelleher, P. O. Box 82, Washington, D. C.—Silk worm eggs, 300 for 25¢.
 Dog portraits of Clayton Dog Remedy Co., Chicago, free.
 V. O. Hammon Co., McClurg Bldg., Chicago—Picture post cards of mammals; \$5 per thousand.
 National Wool Warehouse & Storage Co., Chicago—Exhibit of wool, yarn and cloth, free.
 Detmer Woolen Co., Chicago—Colored calendar showing preparation, of wool. (This should be requested by a local tailor.)

¹A List of Illustrative Material for Botany, Physiology and Zoology, suggested by members of the Central Association of Science and Mathematics Teachers, November, 1914, and January, 1915.

²From list published in *Journal of Geography*, January, 1915.

M. W. Mumford, Rand McNally Bldg., Chicago—Colored plates of animals and plants, \$10.00 per thousand.

Booklets of International Harvester Co., Chicago—Boll Weevil, Cattle Tick, Spraying, Golden Stream, are fine.

Bulletins of U. S. Dept. of Agriculture, of State Departments and Experiment Stations, of Bureau of Fisheries, of U. S. Dept. of Commerce and Labor, and state game and fish wardens or bureaus.

Pere Marquette R. R. Co., Chicago—Booklet on Game Fishes of Michigan, free.

PHYSIOLOGICAL.

M. J. Breitenbach Co., New York City—Bacteriological Chart; fine.

American Medical Association, 535 N. Dearborn St., Chicago, Ill.—*The Great American Fraud*, 185 p., 6" by 8". About patent medicines. Use in physiology classes.

State Board of Health, Lansing, Mich.—Monthly Health Bulletin; fine.

State Board of Health, Raleigh, N. C.—Monthly Health Bulletin; fine.

Metropolitan Life Ins. Co., 1 Madison Ave., New York City—Teeth, Tonsils and Adenoids; First Aid in the Home; other pamphlets. Apply to nearest agent.

Chicago Daily Tribune—"How to Keep Well" column daily by Dr. W. A. Evans; fine.

Chicago Dept. of Health, City Hall, Chicago—Weekly Health Bulletin.

GENERAL.

Illinois State Geological Survey, Frank W. DeWolf, Urbana, Ill.—*Report on Des Plaines Valley*; "Recent State Map," Ill.

Commissioner of Immigration, Winnipeg, Canada—Grain and grasses, free.

Horlick's Malted Milk Co., Racine, Wis.

Walter Baker Co., Milton, Mass.—Free.

Hershey Chocolate Co., Hershey, Pa.—Free.

Huyler's, Cor. 18th St. and Irving Place, New York City—Free.

W. M. Lowney Co., 486 Hanover St., Boston, Mass.—Free.

C. F. Blanke Tea & Coffee Co., 7th and Clark Ave., St. Louis—25 bottles, \$3.00.

McCormick & Co., Baltimore, Md.

Spool Cotton Co., 315 4th Ave., New York City—Thread; free to principals.

Linen Thread Co., 96 Franklin St., New York City—\$3.00.

International Harvester Co., Harvester Bldg., Chicago—Fibre, sisal, etc., 35c.

U. S. Rubber Co., Broadway and 58th St., New York City—\$10.00.

Am. Sugar Refining Co., 117 Wall St., New York City—Free.

Minute Tapioca Co., Orange, Mass.—Free.

German Am. Button Co., Rochester, N. Y.—Button exhibit, 50c.

Fertilizer and By-Products—Swift & Co., Chicago—Free; Morris & Co., Chicago—Free; Armour & Co., Chicago—An elaborate exhibit, \$10.00.

Ill. State Food Commission, 431 Dearborn St., Chicago—An exhibit free and a loan lecture with lantern slides.

INTERESTING TECHNICAL POINTS ON GEMS.

BY FRANK B. WADE,

Shortridge High School, Indianapolis, Ind.

(Continued from May Issue.)

QUESTION 6.—*How have precious stones been imitated and how may such imitations be detected?*

ANSWER.—This question might well require a volume for a full answer and discussion. It is not true, at least in this connection, "that for ways that are dark and tricks that are vain the heathen Chinese is peculiar." The great value attached by nearly all people in all times to precious stones has led to innumerable attempts to imitate them. Very successful imitations were produced in glass by the Egyptians and also by the Romans, and glass of one sort or another has been the universal imitator in all ages. So well qualified in most respects to imitate gems is the heavy, brilliant, highly refracting glass known variously as "strass" or "paste" or simply as lead glass, that about the only respect in which it is lacking is in durability. It is soft and it is also subject to alteration when in contact with the gases found in the air of cities, hence paste imitations will not last or wear well. They will scratch or tarnish all too soon.

So skilful has the glassmaker become that nearly all gems may be successfully imitated in glass, the opal perhaps coming nearest to being an exception. The glass imitations of the opal that I have seen have not been really satisfying.

Glass imitations, too, are frequently cut with more skill so far as observing the correct angles to fit the particular optical properties is concerned than are precious stones. There is no attempt made to save weight at the expense of brilliancy when the cheap "strass" is cut, but it is endeavored to get the most brilliant result possible and when by experiment a desirable shape has been worked out, all the output is thereafter cut to as nearly those proportions as possible. If the cutters of semi-precious stones would treat them as carefully they would average much better than they now do in appearance.

To improve the wearing quality of certain kinds of the glass imitations it has been customary for many years to "top" them with some true gem material making the so-called "doublet" of which thousands are sold.

The material of the "top" is in most cases garnet, which is sufficiently hard and very cheap. The two parts, the glass and the garnet, are cemented together by means of some waterproof cement, such as Canada balsam. Usually only the table portion of the finished stone is protected by garnet. (Fig. 8) In some of the better-made doublets, especially in the smaller sizes, the whole top (all above the girdle) is of garnet (Fig. 9.) But in both kinds the layer of garnet is very thin and the proportion of the stone above the girdle very small.

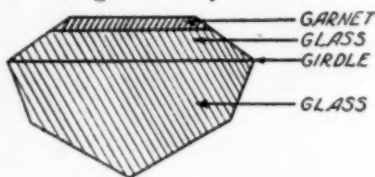


Fig. 8

COMMON FORM OF DOUBLET.

It might be thought that the color of the garnet used for the "top" would be easily detected. This is not so; for, when cemented to a deep blue back, it can at the most impart merely a slightly purplish tint to the blue of the back; when used with yellow, a slight orange tint might result. With green complete absorption of the red light would result and only the green would be seen. With a red back, for a ruby doublet, the two shades of red would blend. In the "diamond" doublet an exceedingly thin slice of garnet is used to cover merely the table, hence it does not impart detectable color to the colorless glass used with it.

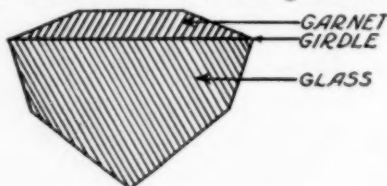


Fig. 9

BETTER GRADE OF DOUBLET.

Recently a still more deceptive contrivance, the triplet, has been revived, especially as a substitute for the emerald which science has not yet succeeded in duplicating. In the triplet the crown (part above the girdle) is of some hard, true stone; it may be colorless beryl (the same mineral as emerald, but not of grass green color), but it is generally quartz. The pavilion (part behind the girdle) is also of beryl or crystal, but the former is likewise of an inferior

color. Between these two parts is inserted a thin slice of deep green glass or sometimes green coloring matter (in the case of the emerald substitute). (Fig. 10.) When cemented together and cut and polished, the product is an excellent imitation of the true stone. If made with beryl it has the proper hardness at all points where it is likely to be tested; its specific gravity is practically correct, and being of the true doubly refracting material, it may show some dichroism. Natural defects may even be present in it.

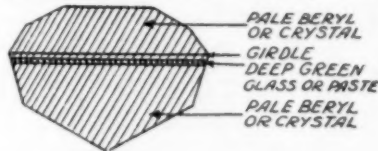


Fig. 10

EMERALD TRIPLET.

In another class from glass imitations and doublets come those comparatively recent productions, the so-called synthetic gems. Here nature's product has practically been duplicated. "How may such imitations be detected?"

The glass imitation is perhaps detected most easily by attacking it, preferably along the girdle, to avoid unnecessarily injuring it, with a fine, clean file. Hardened steel is harder than glass and will easily attack it. In thus testing a stone, care must be used or even true hard stones may be injured by the file, especially on delicate corners or edges. It must be remembered that hardness and toughness are entirely separate properties, although the public seldom realizes this. A steel file—brittle as it is—is tougher than most precious stones and a rude attack on a sharp corner or edge of the stone might result in chipping or knocking off bits of it, although the file at the same time was being deeply scratched by the harder material.

A light, firm pressure is all that is needed to cause the glass imitation to yield to the file, and a whitening of the surface of the "stone" at the point of attack will reveal that it has yielded and gone to powder at that point. A "streak" of the powder of the glass imitation will also be found on the file; whereas, if a genuine stone be attacked, a "streak" of steel will be found on the stone, and the file will be scratched.

Doublets, too, yield to the file, except on the protected top surface.

Both glass imitations and doublets are singly refracting, so if set in such a manner that the file cannot conveniently be used,

direct sunlight may be allowed to fall on the clean stone and a white card held in front of it, as was explained in a previous article. The spots of reflected light will be solitary, not in pairs, with the imitation; whereas, with all precious stones except diamond, garnet and spinel, paired reflections, due to double refraction, will be seen.

In the case of colored stones the dichroscope affords a valuable additional means of detecting imitations, as neither glass imitations nor doublets show dichroism, whereas many true precious stones do.

The doublet may also easily be detected by tipping it until light is reflected to the eye from the sloping side of the upper part. There will be noticed a difference in the character of the light reflected from the garnet top and from the glass remainder. The luster (as the character of the reflected light is called) of the garnet portion is higher and also resinous in character, while the glass has a lesser and more vitreous luster. One with a trained eye will detect a doublet from the sidewalk through the jeweler's window, by moving slowly until a suitable reflection is had from the sloping side of the stone. With a glass the line of junction between the two parts can easily be seen, although lapidaries frequently bring this junction sharply to the girdle and polish it in the better doublets, or bevel the edge, to meet the garnet top in poorer ones, so that somewhat close attention may have to be given in these cases.

Triplets may also be detected by looking for the two lines of junction or by immersing the stone sidewise into oil, when the several strata of color may be easily observed. Glass imitations, and hence doublets, frequently contain minute bubbles of air and these are round or rounding in glass. In precious stones cavities are often present, but they are angular and give evidence of having been forced into the crystalline shape which the material itself took. Thus an examination with a good lens will often reveal the presence of round bubbles and thus show the "stone" to be an imitation. Specific gravity tests will, of course, usually show up imitations, but these are applicable only to unset stones.

The synthetic stones are not exactly in the category of "imitations," as referred to in the question, yet a few words in regard to methods of detecting them from the natural stones may not be out of order.

First.—I should rely upon the presence of the minute, but char-

acteristic, imperfections of the *natural* stone to guide me in determining whether a given specimen was or was not natural. It is exceedingly uncommon to find a natural ruby or sapphire which is entirely free from the well-known natural defects of the corundum gems—the “silk,” the cloudy patches, the angular cavities when cavities are present. These defects I have never seen in the synthetic stones.

Second.—The synthetic stones are always more or less striated, with curving parallel striæ, or lines of color, owing to the method of growth upon a curving dome-shaped drop which grows in size by the addition of successive layers of material from the blow-pipe flame above. By using a sufficiently high magnifying power and by carefully and slowly turning the stone a position will eventually be found in which these striæ will be visible. The darker sapphires lend themselves less readily to this test, but by reflecting the powerful beam of sunlight through them from the concave mirror below, the striated character can usually be seen under the lower powers of a compound microscope, even when it is hard to detect with the simple magnifier.

Third.—Synthetic stones are likely to contain included gas bubbles, and these in the synthetic stones are always round or round- ing, as in glass, never angular, as are the cavities of natural stones. By making use of these three means, one need never be in doubt, after some practise, as to the character of any stone which science has duplicated.

The emerald, by the way, has not, so far as I can learn, been duplicated. There are no true synthetic emeralds on the market. Many which have been offered for sale, with a view to taking advantage of the justly good reputation of the synthetic ruby and sapphire, have been merely clever glass imitations, which the file will attack. They show no dichroism. The appearance of natural flaws has been imparted, in some cases, by allowing whisps of fine air bubbles to remain in the material, and in other cases apparently by pinching the glass and thus making cracks in it resembling those in emeralds.

By actually melting beryl (the mineral species of which emerald is one variety) and by adding chromium oxide to deepen the green color, stones that looked like emeralds have been made, but the material was a beryl glass and was not crystallized. It was, hence, singly refracting and showed no dichroism, whereas the emerald is crystallized, is doubly refracting and shows dichroism.

The product was also lighter in weight and softer than true emerald. Thus the attempt to reproduce emerald from emerald material did not succeed, as did that to reproduce ruby and sapphire. The best of the emerald substitutes now on the market are triplets, to which reference has already been made in this article. They make very durable and very fine appearing substitutes, and are the only really high-grade emerald substitutes that I have seen. When properly represented to the customer who cannot afford a real emerald and sold for a fair advance on their cost, they are entirely worthy substitutes.

QUESTION 7 reads: *Discuss the effect of heating on the coloration of gem stones.*

ANSWER.—We are here reminded of John Ruskin's advice to "absolutely seek out and cast away all manner of false or dyed or altered stones"; and, to the credit of the jewelry trade, it may be justly said that, in general, Ruskin's advice is followed, or else, if the stone offered for sale be false or altered, that fact is made known at the time.

There are some cases of the altering of color of gems by means of heat that are quite justifiable in spite of Ruskin's pronouncement. For instance, the fine pink color which results when true Brazilian topaz of wine color is gently heated scarcely ever occurs in natural topaz. The product, therefore, does not simulate any natural topaz, and that fact protects the public from the use of pink topaz as a substitute for a more costly natural gem.

There are a number of stones which undergo change of color when heated to a greater or less degree, and in general it may be said that the effect of heating is to decrease depth of color. Thus certain zircons lose their color entirely when heated to no very high temperature in an alcohol flame. Other zircons fade partially but not entirely on being similarly treated, the final color being usually a light straw color.

Some of the whitened zircons (or jargoons, as they are sometimes known in the trade) regain more or less color on exposure to light. Others seem to remain white indefinitely. The ultraviolet light from a quartz mercury vapor lamp will speedily restore color to the zircons that regain their color slowly in ordinary daylight.

The whitened zircon, if well cut, greatly resembles diamond, and even one who was accustomed to determining the character of gems might be deceived by one under favorable psychological circumstances. When inclined to be suspicious of the stone its

character would probably be detected, but when suspicion is properly disarmed a finely cut jargoon can usually pass casual inspection as a diamond of rather "sleepy" brilliancy. It is, however, unusual to see a really well-cut jargoon. To give the best possible results they should be brilliant-cut, but not with the same angles as the well-cut diamond. A 39-degree top angle (the top angle is the angle between the plane of the girdle and that of the top slope) and a 44-degree back angle (the back angle is the angle at the culet) will give a very brilliant stone if care be taken to make the facets *absolutely flat* and if the surface finish is well attended to. One of the chief failings of cut stones is lack of true flatness of the facets. Curved facets cause a scattering of the light reflected from them so that it does not carry to any great distance.

It was said above that true topaz of wine color may be "pinked" by a mild heating. If too much heat is used the topaz, like the zircon, loses all color. The whitened topaz, however, is unattractive, for, while fairly brilliant when well cut, it lacks "fire." The white zircon, however, having about 86 per cent as great a dispersion as diamond, is quite fiery.

Much of the yellow "topaz" of the trade, which is only yellow quartz, probably owes its yellow color to alteration by heat while in the rough. Smoky quartz will sometimes turn to yellow or brownish red on being heated moderately. Amethyst also will change with heating, giving an orange-colored stone unless too great heat is employed. In the latter case all color disappears.

It is said that rubies of streaky color are sometimes improved and made more uniform by being heated. The red color of the ruby is, however, not permanently altered by heating, unless in the case of a very light-colored ruby, which may lose its color. While hot the red color disappears, but reappears again on cooling. The other corundum gems, too, resist color change on moderate heating, but heating to a high temperature whitens yellow sapphire.

It is interesting to note that radium radiations tend to reproduce color in whitened sapphire, much as ultraviolet light restores color to whitened zircon. Such radium radiations also tend to produce blueness in diamonds of slightly off color, it is said, but the high cost of radium of sufficient activity has probably served to protect the diamond trade from much nervousness on the score of altered values from this cause.

SOME SIMPLE APPLICATIONS OF ELEMENTARY ALGEBRA TO ARITHMETIC.

BY M. O. TRIPP,

Olivet College, Olivet, Mich.

The object of this article is to show how we may make our first term's work in algebra more concrete and interesting, and at the same time vitally connected with the work in arithmetic which the student has had in the grades. The teacher of beginning algebra always experiences considerable difficulty in familiarizing students with generalized numbers. In passing from the ordinary arithmetic of the grades to the literal arithmetic of first term algebra students frequently fail to make connection, and hence fall into the habit of mechanical manipulation. Arithmetic becomes far more interesting when the student, by means of his algebra, can prove some of the statements which he has merely taken for granted in the elementary school.

One way to make division in algebra more vital is to connect it with the tests for the divisibility of numbers.

Let us consider the test: Any integer is divisible by 2 if its right-hand digit is 0, 2, 4, 6, 8. If the number has two digits it can be represented as

$$10x+y,$$

and hence division by 2 gives

$$\frac{10x+y}{2} = 5x + \frac{y}{2}.$$

The pupil will have no difficulty in realizing that if the quotient on the right is to be an integer y , or the right-hand digit, must be 0, 2, 4, 6, 8. After the student has proved the rule for a number of two digits he can take up a number with three digits in the same way, and finally an integer consisting of any number of digits.

To test a number of three digits for divisibility by 3 we assume the number in the form

$$100x+10y+z.$$

Division by 3 may be indicated as follows:

$$\frac{100x+10y+z}{3} = 33x+3y+\frac{x+y+z}{3}.$$

In order that the right side may be an integer it is necessary that

$$\frac{x+y+z}{3}$$

shall be an integer; that is, that the sum of the digits of the

given number shall be divisible by 3. It is evident that, in like manner, the same test can be shown to hold no matter how many digits the number has.

The tests for divisibility by 4 and 5 are very simple. The practical test for 6 is not obtained by ordinary division, but can most readily be obtained from the tests for 2 and 3.

If we take three digits we get a test for divisibility by 7 from the following division:

$$\frac{100x+10y+z}{7} = 14x+y+\frac{2x+3y+z}{7},$$

That is, a number of three digits is divisible by 7 if the sum of twice the hundreds' digit, three times the tens' digits, and the units' digit is divisible by 7. A working rule can already be obtained, by division as above, for an integer having any number of digits.

Let us test a number of five digits for divisibility by 11. Division of the number in algebraic form by 11 gives

$$\begin{aligned} & \frac{10,000x+1,000y+100z+10w+u}{11} \\ &= 909x+91y+9z+w+\frac{x-y+z-w+u}{11}. \end{aligned}$$

Hence a number of five digits is divisible by 11 if the sum of the odd numbered digits, beginning at the left, minus the sum of the even numbered digits is divisible by 11.

It is evident that tests for divisibility by other numbers can be readily obtained. Division in algebra taught with such illustrations as the above tends to make the student feel at the outset that the subject he is studying is of some use.

The consideration of Pythagorean numbers, that is, triples of rational numbers which may represent the three sides of a right triangle, leads to some interesting applications of the special products found under multiplication in the first term's work in algebra. In preparing problems in arithmetic on the right triangle it is convenient to know how to pick out triples of Pythagorean numbers belonging to dissimilar triangles. The identity

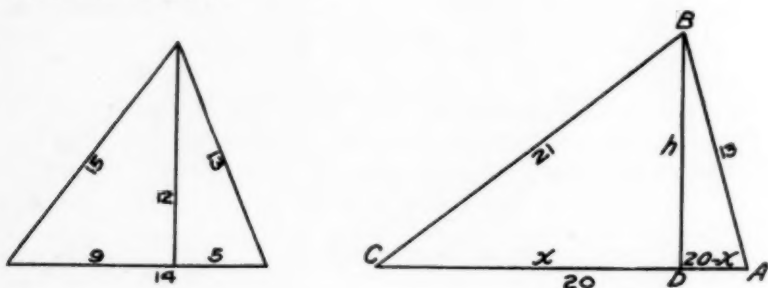
$$(a^2-b^2)^2+(2ab)^2=(a^2+b^2)^2$$

can be used for the selection of such triples. If we give a and b any values different from each other the three sides of a right triangle may be represented by the numbers

$$(a^2-b^2), 2ab, (a^2+b^2).$$

Thus let $a=2$ and $b=1$, and we get the well known triple 3, 4, 5. If $a=4$, $b=1$, we get the triple 15, 8, 17.

By putting together Pythagorean right triangles having a common side we may find triples of Heronian¹ numbers, that is, rational numbers representing the sides of a plane triangle such that the area shall be rational. From the above Pythagorean triple 3, 4, 5 we see that 9, 12, 15 may also represent the sides of a right triangle. But if we take the even number 12 and set it equal to $2ab$ we have $ab = 6$, which is satisfied by $a = 3$, $b = 2$. Hence $a^2 - b^2 = 5$ and $a^2 + b^2 = 13$. Therefore by putting the two right triangles with sides 9, 12, 15 and 5, 12, 13 together with the side 12 in common, we have a triangle with the sides 13, 14, 15 whose area is rational, that is, 13, 14, 15 is a triple of Heronian numbers.



By taking the Pythagorean triangle whose sides are 20, 16, 12 and placing it next to the right triangle whose sides are 13, 5, 12 so that the side 12 shall be common we have the Heronian triple 21, 13, 20.

An interesting application of the rule for finding the product of the sum and difference of two numbers may be made in finding the squares of small numbers. From the identity

$$a^2 = (a+b)(a-b) + b^2,$$

we may get the rule: The square of a number equals the sum of the number and any second number, multiplied by their difference, plus the square of the second number. Thus

$$22^2 = (22+2)(22-2) + 4.$$

This rule enables the student to square numbers up to 100 mentally. The rule works most conveniently on numbers ending in 5.

Another set of interesting exercises which may be proven very readily with a little algebra is that relating to the difference between any number and the number obtained by reversing the order of the digits. The student can readily discover for him-

¹ For a list of Pythagorean and Heronian triples see Halsted's *Mensuration*; Ginn & Co.

self when this difference is divisible by 9 and when it is divisible by 9 times 11.

There are certain problems in fractions which illustrate very nicely how algebra may become a powerful means for the proving of general statements. Let us take the problem: How is the value of a proper fraction affected by adding the same positive number to both terms?

Let x = numerator and y = denominator.

$$\text{Then } \frac{x}{y} = 1 - k, \quad (0 < k < 1).$$

$$\text{Therefore } x = y - ky.$$

Adding a to each side,

$$x + a = y + a - ky.$$

Dividing each side by $y + a$,

$$\frac{x + a}{y + a} = 1 - k \left(\frac{y}{y + a} \right).$$

It is evident that

$$1 - k \left(\frac{y}{y + a} \right) > 1 - k.$$

$$\text{Hence } \frac{x + a}{y + a} > \frac{x}{y}.$$

That is, a proper fraction is increased when the same quantity is added to both numerator and denominator. Other problems can be made by considering improper fractions, or by considering the effect of subtracting the same quantity from each term of the fraction.

Algebra may be used in an interesting way to reduce a repeating decimal to a common fraction.

$$\text{Let } x = .333333 \dots$$

$$\text{Then } 10x = 3.333333 \dots$$

$$\text{Subtracting } 9x = 3,$$

$$\text{or } x = \frac{1}{3}.$$

$$\text{Again let } x = 2.3454545 \dots$$

$$\text{Then } 100x = 234.5454545 \dots$$

$$\text{Subtracting } 99x = 232.2,$$

$$\text{or } x = \frac{232.2}{99} = 2\frac{342}{990}.$$

This method of changing repeating decimals to common fractions is so simple that it can be taught during the first week's work in algebra.

A simple application of algebra to mensuration is that of

finding the area of a triangle when the three sides are given. Let us take the triangle whose sides are 13, 20, 21.

Let $x = CD$.

Then $20 - x = DA$.

From the right triangles CDB and ABD we have

$$21 - x^2 = h^2 = 13^2 - (20 - x)^2$$

$$\text{or} \quad 441 - x^2 = 169 - 400 + 40x - x^2.$$

$$\text{Hence} \quad x = 16\frac{4}{5}.$$

$$\text{Therefore} \quad h = 21^2 - 7056/25 = 3969/25,$$

$$\text{or} \quad h = 63\frac{3}{5}.$$

$$\text{Hence the area} = \frac{1}{2} \cdot 63\frac{3}{5} \cdot 20 = 126.$$

If we take a, b, c as the sides of the triangle we get the usual Heronian formula,

$$\text{area} = \sqrt{s(s-a)(s-b)(s-c)} \quad \text{where } s = \frac{a+b+c}{2}.$$

One reason why beginning algebra often becomes uninteresting is that the teacher does not offer the student enough concrete illustrative material. It is hoped that the above simple applications will be of use to the teacher and will incite him to think up more problems of a simple nature.

MATHEMATICAL EQUIPMENT AND ITS USES.

BY H. C. WRIGHT,

University of Chicago High School.

In January, 1915, it was the privilege and the pleasure of the writer to visit one of the large high schools in the vicinity of Chicago. The high-school district has an equalized assessed valuation of approximately \$8,000,000 and there is levied upwards of \$190,000 for the annual support of the high school. The equipment provided for the athletics, for science, for manual training, for English, for the classics, for music, for drawing, for domestic science, for commercial instruction and for reference work seemed abundant and of good quality. But in the rooms of the seven mathematics teachers I found much the same equipment as was common in high schools a quarter of a century ago. Chalk, erasers, string, rulers, a portion of squared blackboard, several wooden protractors, and some blackboard compasses were in some of the rooms but not in all. The equipment in the possession of the pupils, aside from textbooks and pencils appeared to consist of rulers and loose paper. Although the school may have possessed equipment not in evidence at the time of my

visit, such material was not mentioned in the remarks of the teachers with whom I talked about the matter.

Earlier in the fall of 1914, I visited the high school in an Illinois city of some 26,000 inhabitants and found the mathematics teachers depending upon even less equipment than I saw in the Chicago suburban school.

These two experiences have led me to recite in the following pages the names and some of the uses of material at hand in the University High School of the University of Chicago. I should state at the beginning that if this school has considerable equipment it is principally because the mathematics teachers in the school have asked for what they thought they needed and continued to request the same until it was granted. They hope the end is not yet. Up to this time they have availed themselves of the custom in the school to ask for departmental requisitions in June, the same to be acted upon during the following vacation and subsequent year. A special effort is made by each mathematics instructor to make his needs plainly known to those in position to supply the desired material. And to a considerable extent the requisitions have been honored and the equipment furnished. Perhaps the department has aimed to ask for even more than it expected at any one time so that it would receive all the benefit of any funds allotted to the mathematics department.

One day in December, 1914, an inventory of the mathematical apparatus in the rooms in the University High School used for mathematical instruction showed that each teacher has for his use or for that of the class: two large wooden protractors, two 30° , 60° , 90° wooden triangles and two 45° , 45° , 90° triangles of the same material; five wooden straight edges, several with handles like those on a plasterer's board; nine blackboard compasses; 14 foot-rulers; 10 lead pencils; two small brass protractors; 10 lead pencil compass holders. In one room was a spherical blackboard. In another room hung a five foot slide rule. Each room has a cork bulletin board upon which the pupils' written work might be exhibited. Two of the three rooms contained glass doored cases for the storing of mechanical devices and models used in instruction or the result of the pupil's constructive efforts. Besides these storage cases one room has an exhibit case for written work. This case contains 25 revolving panels similar to the cases used in the Chicago Art Institute to display photographic copies of the masterpieces. Thus any year's work

of the entire mathematics department may be displayed though kept in a compact form. Then, too, each room had a section of squared blackboard for graphic problems and a supply of colored crayons. Scissors and string were also available.

Besides the equipment common to each room the mathematics department has a full complement of surveying instruments: two transits, level, leveling rod, steel chain, several steel tapes, wire pins, red and white sight rods, and engineer's notebooks for field work. There is also a high grade Duplex 10" slide rule for use by either teachers or pupils.

In addition to the general room equipment the individual pupil carries a notebook containing ruled and unruled paper, squared paper, and attached to the rings of the notebook is a ruler, a brass protractor, and a pencil compass. Thus, the pupil can undertake a variety of laboratory mathematics during the classroom exercise. For the written theorem assignments there is a printed form that the pupil may buy and use if he chooses to go to that expense and thereby add to the neatness of his work as well as save some time in doing it.

The acquirement of all this varied material for the demonstration and the presentation of the mathematics taught in the high school has to a large extent grown out of the unification of the first three years of the ordinary secondary-school course, the first two years of which are developed from geometrical concepts. The first-year book in mathematics contains many of the facts and ideas of plane geometry and the algebraic quantities have a geometrical interpretation. In the second year the algebraic facts acquired during the first year are again brought out by assigning algebraic values to the geometrical material presented.

This unification of the algebra and the geometry presents many opportunities for the pupil to use mechanical drawing instruments, both to solve and to illustrate problems. In this way he has constantly before him the practical application of algebra and geometry to each other, and can illustrate one subject in terms of the other. For example, when he makes a study of the equation $3x + 4y = 9$, his attention is called to the algebraic and geometric representation of the same idea. Or again, when he first learns to multiply $a+3$ by $a+4$, it is by seeing a parallelogram whose area represents the product of these two factors. The parallelogram is divided so as to show that one part is a^2 ; a second part is $3a$; a third part, $4a$; and the fourth part, 12. Thus he has the area expressed geometrically and algebraically. In the geometry of the second year he is told, for example, that

one of the equal angles of an isosceles triangle is $10x^2$ and the other $40x-40$. He is then asked to find the value of x , the size of each angle, and to construct a triangle satisfying these conditions. In performing the required operation, the pupil needs to solve the quadratic and to construct angles of 20° and 140° . If this be made a class exercise, each pupil works at his desk, using his individual equipment, and later some one pupil demonstrates his results to the class, making use of the room blackboard equipment and actually obtaining the required triangles. In case the problem has not proved too difficult for any member of the class, the instructor assigns a second problem, meanwhile passing from pupil to pupil to supervise the class work.

This constant use of the drawing and measuring apparatus at hand to solve and to illustrate the problems in mathematics seems to create in the minds of the pupils the idea that mathematics is a single department of knowledge in which algebra, geometry, and trigonometry are but different modes of expressing the same facts. For example, the pupil may have drawn a right-angled triangle so that the hypotenuse is twice as long as one of the sides about the right angle. He may have lettered the hypotenuse $2a$ and the one side a , and he may have expressed the fact that the

$$\text{sine of angle } A = \frac{a}{2a} = \frac{1}{2}.$$

Then he may have drawn on squared paper or blackboard a right-angled triangle in which the hypotenuse is 8 units long and the side opposite angle A 4 units long, from which figure he found with the protractor angle A to be 30° . This enables him to find that the sine of $30^\circ = \frac{1}{2}$. He has in this operation used arithmetic, geometry, algebra, and trigonometry, and meanwhile he has been engaged in his second-year mathematics. The geometry furnishes space material to illustrate algebraic principles, which by means of his knowledge of algebra he is able to carry a process beyond the limits set by the geometry.

Another field for the profitable and pleasing use of the material equipment is the study of scale drawing and similar triangles. This makes possible the solution of surveying problems involving measurement, as the problem of finding the distance from each of two land forts to a vessel off the harbor. In this work the pupil may choose to use colored inks with the result that he often succeeds in making a very attractive piece of drawing according to careful measurements, and a correct application of geometry and algebra to a concrete problem.

Again, in third-year mathematics several days may be spent in field work. The height of a tall smokestack is found from data obtained by establishing a base line and then measuring several angles of elevation. This problem may be solved by a scale drawing or by the use of the trigonometric formulas. A second problem is to run a line of levels from a given benchmark to a second benchmark some hundreds of feet away. A profile drawing on squared paper will then be made from the data taken. Another interesting problem is to find the distance of one of the Lake Michigan water cribs from some shore point. The following problem is apt to arouse considerable interest as well as to illustrate the concrete use that is frequently made of an engineer's notes. The class is divided into two sections, one taking field notes which locate some particular object, the other using the notes of the first section to re-run the lines which locate the object.

The presence of all of the equipment thus far referred to stimulates the pupils to make various models to illustrate the solid geometry. By using wire, knitting needles, corks, and light lumber or cardboard the pupils make models to illustrate a number of the theorems in solid geometry. The fact that these models may be preserved from year to year in the glass cases installed in the rooms makes it possible for the teacher to have at hand the best constructive products from a large number of pupils of the preceding years.

Each spring, generally in May, an exhibit of the best work of all the mathematics classes is arranged for display to the whole school and those parents, friends of the school, and other persons interested in the teaching of mathematics, who may come to view the collections. The drawings and written work are mounted according to some uniform plan and then hung on the walls of some room or of one of the corridors. The models are set out on tables or in glass cases. Thus the mathematics department takes part in the education of the hand along with the training of the mind. The results obtained from a liberal use of the equipment mentioned above justify the possession and the application of all this varied assortment of material.

ERRATUM.

Page 457 in May, 1915, number. Determinant should read:

$$\begin{bmatrix} \sin a & -(\cos a + \frac{1}{2}b) \\ \cos a - b & \sin a \end{bmatrix}$$

THE INFLUENCE OF THE TRANSCONTINENTAL HIGHWAYS OF THE UNITED STATES ON THE PRICE OF WHEAT.¹

BY N. A. BENGTON,

Associate Professor of Geography, The University of Nebraska.

This paper deals with some regional differences in the farm values of wheat in the United States. It is an attempt to call attention to some "highs" and "lows" in the farm prices of this generally produced cereal, and to suggest a geographic control which seems vividly illustrated.

The general demand for wheat and its extensive production in so many countries give it a world market, of which Liverpool is the recognized center. The price of wheat on the Liverpool market is the accepted resultant of the production of this grain and the industrial conditions which affect the demand for it. This serves to set a standard which, being delicately balanced and responsive to ever-changing conditions, is consistently maintained. The prices in the various parts of the United States represent this world price as modified by local conditions. That these conditions are important is readily appreciated from the fact that the price paid the American farmer for wheat December 1, 1914, varied from 86 cents to \$1.45, a difference of nearly 70 per cent.

Among the commonly recognized controls in the price of wheat may be named the following: Quality, based on desirability for making bread; distance to market; exporting or importing region. The cost of production, broadly considered, is not a local control of the price. It affects profits and often determines whether or not wheat shall be raised in a given locality but with the exception of remote or isolated places, affects prices only as a great world control.

WHEAT GENERALLY PRODUCED IN THE UNITED STATES.

A study of the wheat situation in the United States reveals the fact that only two states, Louisiana and Florida, are not quoted as producers of commercial wheat. As an exporting nation we must deliver our excess wheat to the foreign markets, and in consequence bear the expense of such delivery. By deducting our exports from the total production we find that the average home consumption of wheat 1909-1912 inclusive was 6.19 bushels per capita. Using this as our standard in determining which states produce wheat in excess of home demands and which are deficient

¹ This paper was read at the annual meeting, Association of American Geographers, Chicago, December 29, 1914.

in local production, we find the country nearly evenly divided. (See Figure 1.)

WHEAT PRICES.

In this grouping of the states we can determine the approximate value of the importing versus exporting factor in the price of wheat. During the decade 1900-1909 the farm price in the states deficient in home production averaged 92.7 cents per bushel whereas in the surplus producing states, the price averaged only 77.2 cents. The difference, 15.5 cents per bushel, represents the average price advantage enjoyed by the wheat farmers of the states deficient in wheat production over those in the states producing a surplus.

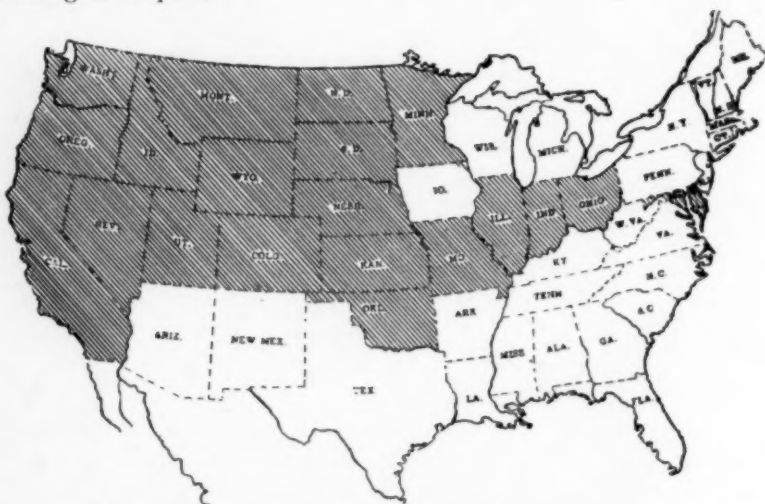


FIG. 1. Wheat Production in the United States. Shading shows States which produce surplus wheat.

The prices which prevail within the regions are especially interesting. Thus in the area of surplus wheat the prices on December 1, 1913, ranged from 63 cents in Idaho and 71 cents in Nebraska to 90 cents in Ohio and 95 cents in California. Practically the same type of difference has prevailed continuously since 1870. In the area where insufficient wheat is produced to supply the state's own demands the prices paid to producers December 1, 1913, varied from 76 cents in Iowa to \$1.30 per bushel in South Carolina.

CAUSES OF DIFFERENCES IN PRICES.

In accounting for these prices, difference in quality of wheat raised is not sufficient. For illustration, among the surplus pro-

ducing states it is acknowledged that the wheat produced in Nebraska yields flour of excellent bread-making properties. Ohio wheat, though of splendid quality, is not superior to the wheat of the Dakotas or Minnesota. Yet Nebraska or Dakota wheat sells at lower prices than does the wheat of Ohio. Apply the same test to the states deficient in wheat production. No one would question that the wheat of Virginia produces flour which is at least equal in bread-making qualities to the wheat of South Carolina. Still the farm prices quoted show that the wheat producer of South Carolina receives considerably more per bushel than does the wheat producer of Virginia. We must then conclude that though differences in the milling quality of wheat may cause local variations in prices, they are not sufficient to account for the great differences which maintain in the various states.

Distance from market is certainly an important reason. No one would gainsay that the relatively low prices which maintain in Nebraska and the Dakotas in comparison with those in Maryland and Delaware are due primarily to distance from the great market centers. The states of the Central West must deliver the wheat to the eastern markets. But there are cases where distance alone fails to afford complete explanation. For instance, the distance from North Dakota to Maine is nearly 50% greater than from Kansas to South Carolina, yet the farm value per bushel of wheat in the latter state is from 6% to 20% higher than in Maine. The illustration seems fair of a typical condition because in each case an inland exporting state having no great market of its own is connected with an eastern importing state.

"HIGHS" AND "LOWS" IN PRICES OF WHEAT.

A careful study of price data shows that for wheat there are three centers of relatively high farm values per bushel and two centers of relatively low farm values. The three former are in Maine, South Carolina and Arizona, the two latter in Idaho and Nebraska. In order to bring out as clearly as possible the relations of these centers to surrounding states and to the great trade movements of wheat, an attempt is made to provide graphic illustrations.

The wheat movements in the United States may be grouped into three great divisions—eastward to North Atlantic seaports, southward to Gulf ports, westward to Pacific ports. For this reason, east-west price profiles have been made for northern, middle and southern United States, and a north-south price profile for the west Central states, North Dakota to Texas. The

Atlantic seaboard farm prices, Maine to Georgia, are similarly illustrated.

The profile of farm wheat prices in northern United States (Figure 2) shows clearly the general upward trend toward the east. In the early part of the decade, northwestern wheats were not in as high favor for bread-making as at present, and export trade from that region was but slightly developed. These conditions serve to explain the general depression shown during that period. The increased favor of northwestern wheat, a better developed export trade, and the rapid growth of western cities is now causing the curve to bend upward, but its value, both vertical and horizontal, is not nearly as great as that toward the east. The curve for 1913 is considered typically modern. The depression in Idaho is due primarily to two factors. Distance

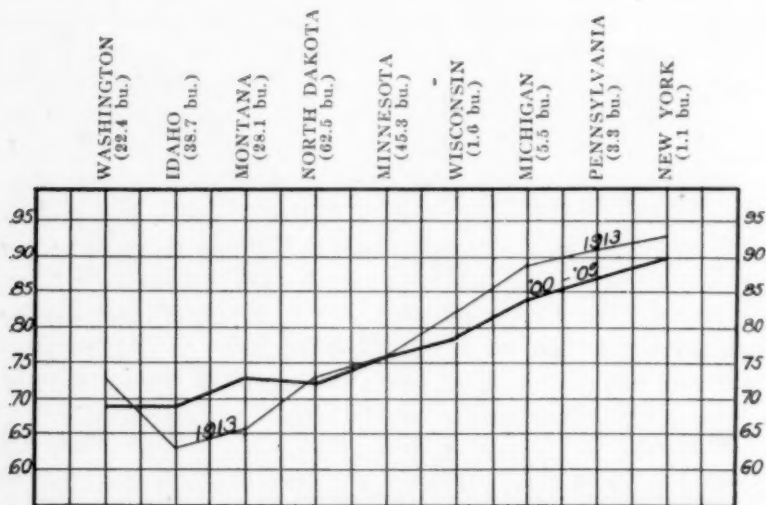


FIG. 2. Farm value of wheat, price per bushel west-east section of the Northern United States.

(Per capita production of wheat is given in parenthesis under each state. The same plan is used in following graphs.)

from great markets in a region where freight rates are high serves to seriously lower farm wheat prices of any exporting region. For that reason, Idaho should be in about the same position in the scale as Montana because the two states are on the divide between the eastward and westward movements of wheat. But Idaho wheat is generally several cents per bushel lower than that of Montana. Difference in milling quality is hardly a suffi-

cient reason for both states produce common wheat and macaroni wheat each high grade for its purpose. The chief reason then appears to be based on transportation. The wheat region of Montana is well served with transcontinental railroads and wheat raising has developed along these highways. Local haulage is relatively short and inexpensive. In Idaho extensive wheat raising has developed in sections which are not so well served with such highways. Local haulage averages longer and the terminal markets are not as easily accessible. Hence in Idaho the lack of well distributed transcontinental transportation service keeps farm prices of wheat relatively low. Let it be understood that this discussion does not consider profits of production. The same factors which cause wheat to be low-priced prevent high prices of land, retard advance of speculative prices, and thus in a measure compensate for the lower prices of the product of the land. Anomalous as it may appear, it is true that wheat is raised most profitably where farm prices paid are relatively low.

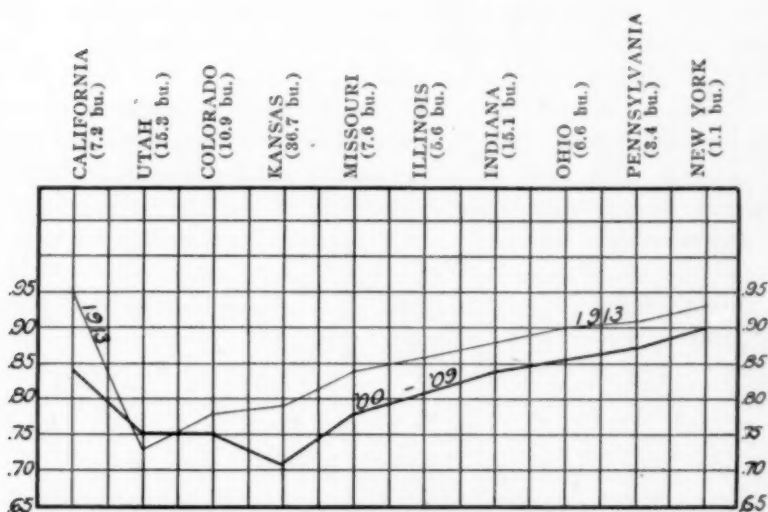


FIG. 3. Farm value of wheat, price per bushel west-east section of United States, middle latitude.

The west-east profile of the middle latitude of the United States shows the same general characteristics as that of the north. (See Figure 3.) It is noted, however, that the up-curve in California is pronounced and apparently becoming more so. This characteristic is not difficult of explanation. California has a well developed export center and a large city at the Golden Gate.

The wheat region of the state is within easy reach of this export center and is served with direct transportation facilities. Nevertheless, the great increase of urban population and a consequent readjustment of agricultural pursuits are rapidly changing California from a wheat exporting to a wheat importing state. This tendency is reflected in the curve of 1913.

At first glance it would appear that Colorado is not in accord with the general principles suggested. It is an exporting state, no better served with transcontinental highways than is Kansas and is farther from market—nevertheless farm prices of wheat are higher. The reason for this apparent discrepancy lies in the fact that some wheat is produced in the valleys of the state but not enough to satisfy home demands. That causes the west half to be an importing section and wheat producers there profit by that condition. They receive the benefit of the cost of the double haul from the eastern part of the state, so of course a high price results. These high farm prices are then averaged with those of the eastern part and the result places Colorado above Kansas. Could Colorado be divided it would be found that the area of lowest depression in this curve would be in the eastern part of that state and in western Kansas.

It will be observed that New York is used as the eastern terminus of this curve as well as of the preceding one. The reason is apparent. The bulk of the eastward moving wheat north of Kansas passes through that gateway. In this connection it may be noted that the influence of the Great Lakes-Hudson highway is to tend to equalize the difference of farm prices of wheat in New York and the Central West. This is due to the low freight rates made possible by this all-water route. For instance, the freight rate on a bushel of wheat from Chicago to New York City in 1912 by lake and canal was 5.38 cents whereas by all-rail route it was 9.73 cents. The difference in farm value is of course greater than merely the difference in freight rates between the places. Several middlemen must be paid for handling the wheat and there is also the short haul to central market to be considered. That this latter is important is shown by the fact that the rate on a bushel of wheat from central Nebraska to Omaha, a distance of 200 miles is eight cents, while from Omaha to Galveston, a distance of 1338 miles, it is only 11.7 cents. It seems then that we are justified in concluding that if it were not for the influence of the Great Lakes-Hudson highway the curve illustrative of wheat prices in Pennsylvania and New York would more nearly resemble the curve leading to San Francisco.

The southern United States is a wheat importing region. (See Figure 4.) With the exception of California not a state listed is self-sustaining in wheat, and California is an exception only because of the wheat produced in the northern part of the state. The Mississippi river and valley is the great transcontinental highway from the wheat producing region to the southern section of the United States. The influence of this highway in producing a depression in the curve is clearly shown. In the west, California is so situated as to profit by the Pacific highway as the route of wheat shipped in from the north, hence the depression in the curve there. Arizona marks the position of an area of high price of wheat because of its location in an importing region which is not served with a low-rate transporting highway. Texas and Mississippi, likewise wheat importers, have lower farm wheat values not only because of nearness to wheat regions, but also because of the low priced transportation facilities made possible by the Mississippi highway.

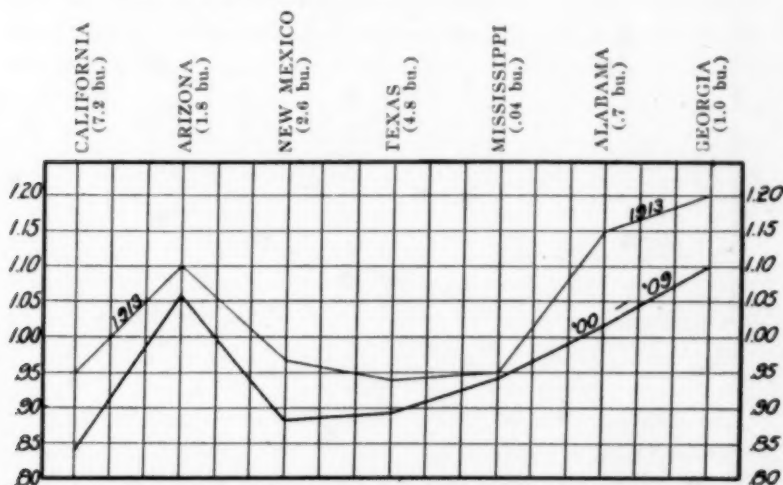


FIG. 4. Farm value of wheat, price per bushel west-east section of Southern United States.

In the north-south profile of the middle west we note that farm values per bushel in North and South Dakota are nearly the same. (Figure 5.) Conditions as to quality of wheat, distance to market, and transportation facilities are about equal. Both states send their surplus wheat eastward. Nebraska, however, shows a slight depression in the curve. But few people realize that Nebraska has, since 1880, nearly always been the center of the lowest farm value of wheat of any state in the Union. Kansas, though

a greater per capita producer, shows higher average farm value. This cannot be attributed to superior quality for both states produce hard wheat of good milling quality. The difference in farm value per bushel is probably due primarily to difference in market situation. South Dakota exports wheat to the east, Kansas principally to the south. Nebraska is on the "divide" between the two great movements, and because of such position must accept the lower prices. The price curve rises to the south as a result of the decreased distance to centers of export. The sharp rise in Texas is due to the fact that it is an importing rather than an exporting state.

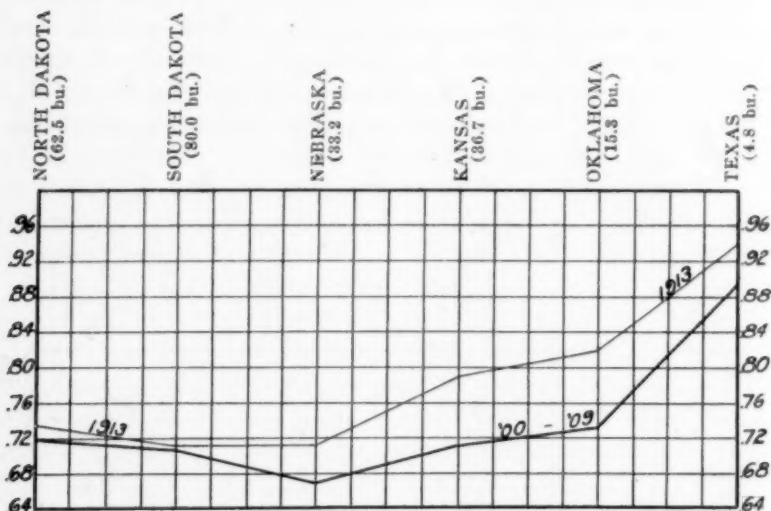


FIG. 5. Farm value of wheat, price per bushel north-south section of the middle west.

The states shown in the northeast-southwest section represent conditions that are typical of eastern United States. (Figure 6.) All are wheat importing states, hence prices are relatively high. This group is so situated as to be served by two great highways, —(1) the Great Lakes-Hudson with the railway trunk lines paralleling it, and (2) the Mississippi valley similarly served with great railroads. The influence of these highways in producing markedly lower prices is indicated by the depressions in the curve. If data of same relative value were given for the Canadian provinces to the north a similar depression would be observed for Quebec. The St. Lawrence and the New York outlets represent the termini of the two greatest eastern transcontinental highways. These highways, reaching to the heart of the wheat

country, place this cereal within the reach of consumers at relatively low prices.

Localities less favored must pay for a more complicated and indirect haul. Maine is illustrative of such a situation. It is on the divide between the St. Lawrence and the Mohawk-Hudson highways. But import wheat is more easily accessible for Maine than for South Carolina. The fork of the St. Lawrence, and the Hudson-Mohawk highways is of smaller angle than the fork made by the latter with that of the Mississippi. Thus, although the location of South Carolina is similar to that of Maine it occupies a more pronounced divide, i. e., figuratively speaking, its summit lies higher. As previously mentioned South Carolina is much nearer in cross country distance to a great wheat producing region than is Maine. But the former lies directly behind the great Appalachian barrier and hence lacks direct transportation facilities to the centers of wheat production, while the latter state, though not directly connected, is within comparatively easy access to the Hudson gateway. Georgia is on the descending slope of the curve, a slope which it is recalled reaches its lowest point in Mississippi beyond which the curve rises to another summit in Arizona.

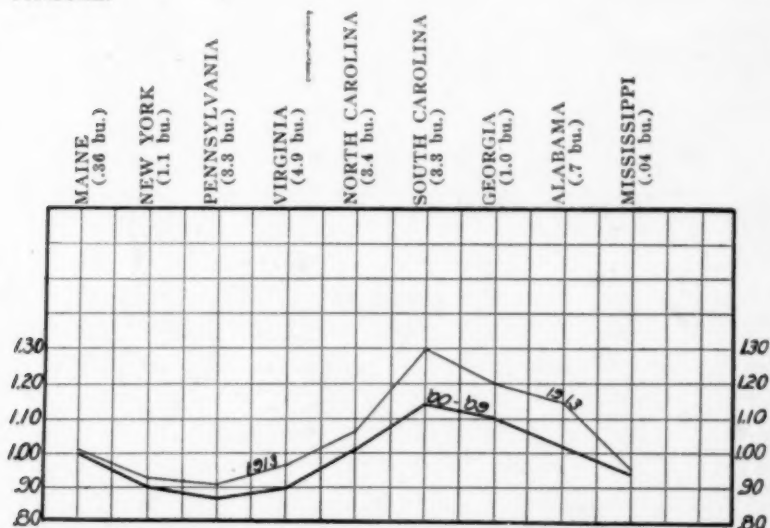


FIG. 6. Farm value of wheat, price per bushel northeast-south-east section of Eastern United States.

The six states which have the highest average farm value of wheat per bushel have been selected for illustration in Figure 7. New York and Mississippi were added for comparison, because

of their locations at the termini of highways. These states it will be observed are all deficient in wheat production. Markets are determined by import rather than by export conditions, and as a result prices are comparatively high. Quality of wheat does not account for the difference in price, for the wheat of Maine or Arizona is not inferior to that of South Carolina. Distance alone is not a sufficient reason for the states of highest price are not situated farthest from wheat granaries. It is observed that three summit areas are shown and that these are separated by two depression areas which mark the location of great transcontinental highways, one to the east, the other to the south.

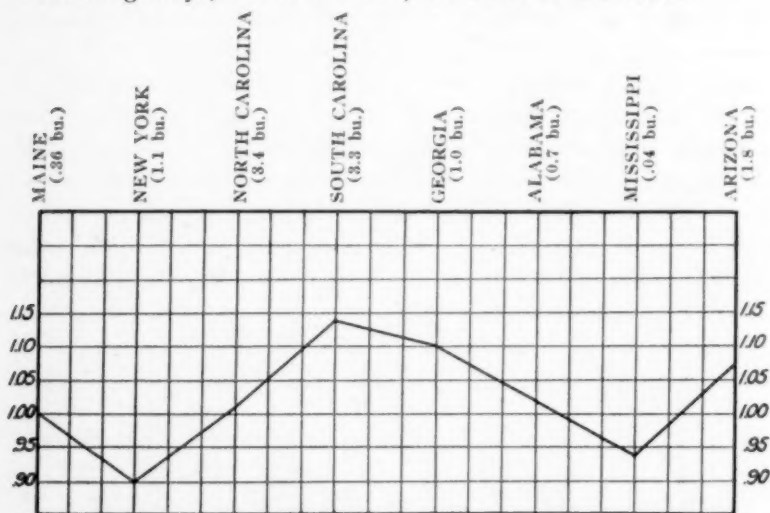


FIG. 7. Six states of highest farm value of wheat per bushel—1900-1909 inclusive—with New York and Mississippi added for comparison.

SUMMARY.

In conclusion then, it is suggested that while, as is commonly understood, the greatest general control of the farm price of wheat is whether a region is exporting or importing, within such regions accessibility to transcontinental highways is of first importance. For exporting regions such highways render maximum prices available, for importing regions they place the product within reach of the consumer at minimum prices. Locations on the "divides" between such highways cause low prices in exporting regions and high prices where wheat must be imported. As illustrative of this principle, we have Idaho and Nebraska occupying centers of low prices in the wheat exporting regions, and Maine, South Carolina and Arizona as centers of high prices in the wheat importing regions of the United States.

**A STUDY OF THE COMPARATIVE COST OF PRODUCTION
OF HOME MADE AND BAKERS' BREAD.**

BY FLORENCE L. KENWAY,

State Normal School, Santa Barbara, Calif.

At Teachers College, Columbia University, in a course in Experimental Cookery, some work was done in studying the cost of the production of bread and comparing the homemade article with the commercial product. The following statement was the basis for the investigations.

A dealer in a certain town claimed that from one barrel of flour costing five dollars he made three hundred and fifteen loaves of bread, which he sold for five cents each. The problem to be worked out involved the consideration of how much went into the bread besides the flour, how much was expended for labor, and for plant, and how much was left for gain.

Three hundred and fifteen loaves of bread at five cents each would bring a return of fifteen dollars and seventy-five cents. Deducting five dollars for the flour, ten dollars and seventy-five cents is left to pay for the other ingredients, the cost of production, handling, rent, fuel and profit.

A barrel of flour was purchased by the department and several lessons devoted to bread-baking. The following points were noted each time—the exact measure of sifted flour, the weight or measures and costs of all ingredients, the weight of the dough, the weight of the finished loaf and the per cent loss in baking. Records were also made in each case of the time of mixing, the first raising, shaping, second raising and baking, efficiency being developed in manipulation and planning. From the weight of the finished loaf was calculated the cost per pound of the bread. The class averages were recorded as well as the individual results.

In baking, the meter was consulted in order to determine the number of cubic feet of gas necessary for baking. This cost was compared with the cost of baking with different fuels, coal, kerosene, electricity and alcohol being used, and also the fireless cooker. A study of oven temperatures was thus involved. The temperatures at the beginning, the highest, the lowest, and the average were noted.

In order to get at the exact cost of bakers' bread, commercial loaves were purchased at various places. The results showed the least bread obtained for five cents to be ten and seventy-five

hundredths ounces—the most, fourteen and five-tenths ounces, the average being fourteen ounces. For ten cents the least obtained was seventeen ounces(a loaf of fancy bread) and the most thirty-four ounces. The economy of purchasing one ten-cent loaf or two five cent loaves or ten cents' worth of rolls was considered. The above figures show that the lowest price per pound for bakers' bread is five cents and the highest eight cents, the average being six cents.

According to the dealer's figures, his expenses for a baking were as follows:

Flour \$0.90 for $24\frac{1}{2}$ lbs.
 Shortening \$0.08 for $\frac{1}{2}$ lb.
 Salt \$0.02.
 Yeast \$0.12.
 Total for materials \$1.12.

This amount of material should give thirty-eight pounds of bread dough, on the basis of 3.75 pounds of flour to one quart of water.

From this quantity twenty loaves of 1.75 pound each should be made, that being the average weight of a ten cent loaf. The cost of the material is then \$1.12 as against \$2.00, the selling price of twenty ten-cent loaves. This leaves \$0.88 to pay for cost of production and profit. About the same result would be reached if this same dough were made into 40 five-cent loaves of 14 oz. each.

The following figures were obtained from the class work on homemade bread, in the laboratory:

Cost for bbl. of flour.....	\$5.75
Butterine, 7.94 lb. @ \$0.22.....	1.75
Lard, 7.58 lb. @ \$0.20.....	1.52
Sugar, 6.7 lb. @ \$0.06.....	.40
Milk, 30.35 qts. @ \$0.09.....	2.73
Yeast, 243 cakes @ 0.02.....	4.86

Total materials\$17.01

Total number of loaves, 243.

Cost per loaf, \$0.07.

Total weight of dough, 324.8 lb.

Total weight of bread, 299.6 lb.

Cost per pound for bread, \$0.057.

Percentage loss of weight in baking, 7.76%.

On comparing these figures with those of the baker, we find that his bread costs us five and one-half cents per pound as against the five and seventh-tenths cents per pound it costs us to produce it. The cost in the experiment was increased by the large amount of yeast used to hasten the process, but on the other hand, the cost of fuel is not included in these figures. The evidence is then clearly in favor of buying bakers' bread, as far as expense goes. Of course, this is not taking into consideration the aesthetic side of the question.

These figures are of especial interest at this time when the cost of flour is soaring and the bakers are considering raising the price of bread. Much as we regret the increased cost of living, we must be fair in studying like problems before condemning dealers for what at first thought seems exorbitant charge.

A DISCUSSION OF MISS KENWAY'S STUDY OF COSTS IN CONNECTION WITH BAKERS' AND HOME MADE BREAD.

By the Home Economics Editor.

The writer has heard of a high school physiology class which became so unruly in the hands of a young teacher, that the principal, in despair, sent a colleague of some years' experience in science teaching to investigate and diagnose the situation if possible. The young teacher then summed up her difficulties in this sentence: "We have already gone through the textbook once, and have nearly finished it again, and the term isn't half over yet—what *am* I to do?"

One who has at all considered the vast range of problems presented and material at hand for home economics teaching, might well suppose that the despair of the inexperienced home economics teacher would arise from a situation quite the reverse of that described above. Yet it seems that this is not always the case. "It's no use to give a bread lesson, for they've already had that in the grades," remarked one high school teacher. The above description of the way in which a college class went at a cost problem in connection with bread-making, may prove suggestive to high school teachers who are planning less elaborate studies of similar topics.

As Miss Kenway remarks, it must be remembered, in interpreting results quoted, that the cost of the laboratory loaf is unduly high, owing to the large amount of yeast needed to shorten the process of bread-raising so that the lessons may be completed

within available laboratory hours. We may, then, easily supply a correction giving the cost of yeast per loaf as it is usually made in the home, under good conditions, so that the figures may be made still more useful. E. g., let us suppose that this same two-cent yeast cake had been used to make four loaves of bread instead of one—then that would reduce the yeast-cake item from \$4.86 to about \$1.20, and the total bill for materials from \$17.01 to about \$13.35; the cost per loaf, from \$0.07 to about \$0.05 $\frac{1}{2}$, and the cost per lb. from \$0.057 to about \$0.04 $\frac{1}{2}$.

Moreover, it should be noted that the retail prices quoted for the homemade bread, especially for lard and milk, are very high, even in 1915, for many parts of the country. Again, the amounts of material used by the Columbia classes are those for a generous recipe, particularly so in case of fat; a more usual home recipe would be one using half the amount of fat mentioned here, or even less than half, for the same amount of flour; also a smaller amount of sugar is often used.

The successful homemade loaf of bread is not only more attractive and more palatable, perhaps in some cases more digestible than the average baker's loaf, but also it has commonly a higher food value, for two reasons. First, it is likely to be higher in milk, shortening, and sugar, as may be noted in formulas given below. Assuming that this baker's loaf contained the same amount of flour in the pound of bread, as does the homemade (as Miss Kenway, in the absence of definite data, had to do), we should have a calorie valuation about as follows:

Bakers' bread, loaf weighing about 1 lb. when fresh.

Flour, 0.645 lb., or.....	293	gms.,	calorific value	1034
Lard, $\frac{1}{2}$ tablespoonful.....	6	gms.,	calorific value	54
Yeast, one-sixth of a two-ct. cake				
of compressed yeast	2.3	gms.,	calorific value	3
Salt, possibly 1 teaspoonful.....	7	gms.,	calorific value	—
Water, about $\frac{1}{3}$ pint.....	162	gms.,	calorific value	—
Total weight before baked.....	470.3	gms.,	calorific value	1091

Home made loaf weighing about 1 lb. when fresh.

(Materials used in recipe of family size would be, $\frac{1}{2}$ pint water, $\frac{1}{2}$ pint milk, 4 tablespoonfuls shortening, 2 tablespoonfuls sugar, 1 teaspoonful salt, one cake of compressed yeast, 3 or more pints of flour as needed. All measures are level, of course.)

Flour, 0.645 lb., or.....	293	gms., calorific value	1034
Lard, 1½ tablespoonfuls.....	18	gms., calorific value	162
Yeast, 1/6 of cake.....	2.3	gms., calorific value	3
Salt	6	gms., calorific value	—
Milk, about 3/16 pint.....	82	gms., calorific value	57
Sugar, ¾ tablespoonful.....	9.75	gms., calorific value	39
Water, about 3/16 pint.....	90	gms., calorific value	—
Total weight before baked.....	501.05	gms., calorific value	1295

It seems perfectly fair to compare these two loaves which are of the same size and contain about the same amounts of flour and of liquid—even though the homemade loaf is an ounce heavier, on account of added shortening, sugar, and milk solids. Moreover the average home-made loaf is more thoroughly baked than the average baker's loaf; this amount of dough would make a pound loaf, in the hands of most housekeepers.

As will readily be seen, this gives us a balance of about 200 calories to the pound, or perhaps ten to twenty calories to the slice, in favor of the homemade bread; a difference equal to almost 20 per cent of the total value. Another and equally important difference, however, is due to the fact that the baker's recipe (in some cases, at least) uses more water in proportion to the flour, than does the homemaker; this gives his bread greater weight and bulk for the same initial expense, but at the same time reduces its calorie value rapidly. In case of one baking company whose formula happens to be known to the writer, this decrease in flour amounts to almost 25 per cent when the dough is mixed, presumably about the same in the baked loaf. Although it is true that they put back a part of this value by using condensed milk for about 10 per cent of the liquid supplied, yet the 1091-calorie pound loaf has its value reduced by at least 160 calories or more probably by twice that, so far as we can judge the composition of the condensed milk. This gives us a balance of at least 364 calories in favor of the homemade bread; i. e., its value is at least 39 per cent above the baker's pound for pound, so far as fuel or calories may be in consideration.

One has also to remember that over 30 of these lost calories are protein calories, and that these have an added significance beyond the question of fuel value.

The baker giving Miss Kenway his estimates of the cost of his materials, has evidently quoted retail prices; 90 cents was a good price for a 24½ lb. sack of excellent bread flour, in 1914; 16

cts. a lb. for lard seems quite enough for any section of the country; and it is hard to imagine that bread in which so much as 2 cents' worth of salt had been used to 25 lbs. of flour, could be palatable!

To summarize, then: Here are valuable suggestions towards the study of a topic of almost universal and very great practical importance, a topic in which high school girls are easily interested and toward which they can contribute a great deal, provided their results are carefully systematized and wisely interpreted. In order that such may be the case, the following details should receive attention:

1. Some consideration of bakers' recipes is necessary and of the composition as well as quantities of ingredients used, especially with regard to fuel values and amounts of protein. This should accompany data showing cost of bakers' bread per lb. to the consumer and a carefully filled out score card judging general excellence of bakers' samples. Such score cards have been printed in many pamphlets and books; e. g., Miss Bevier's *Some Points in the Making and Judging of Bread* (Household Science Department, University of Illinois) and in almost all recent texts on foods for high school use.

2. A similar study is of course to be made of homemade loaves successfully baked in the laboratory from a variety of recipes, and carefully scored by the class. The cost of ingredients should be carefully figured, also calorie values due to each. These last considerations will not be too difficult for high school girls if the teacher supplies them with a carefully prepared table giving weights, calorie value, and cost of the standard cupful and tablespoonful for each ingredient. Such a table would run somewhat as follows (though it must be remembered that measuring cups and spoons will vary somewhat in capacity):

Measure	Weight	Cal. Value	Price	Cost
Water 1 cupful	236 gms.
Milk 1 cupful	245 gms.	169 cal.	8 cts. per qt.	\$0.02
Sugar 1 tablespoonful	13 gms.	52 cal.	6½ cts. per lb.	.0018
Lard 1 tablespoonful	12 gms.	108 cal.	13 cts. per lb.	.0035
Yeast, Fleischman's compressed,				
1 cake	14 gms.	19 cal.	2 cts. per cake	
Flour, Pillsbury's Best or similar grade, cup filled by dipping into once-sifted flour,				
1 cupful	116 gms.	409 cal.	4.4 cts. per lb.	.01

(Sherman's factors used instead of Rubner's; i. e., 4 calories per gram for protein and carbohydrate, 9 per gram for fat.)

(Differences in protein grams or protein calories due to different recipes, may be similarly included if the teacher thinks it wise to attempt this.)

It would probably be well to preface the use of such a table by a few weighing and measuring exercises in which the students try to determine these values for themselves. There will, of course, be wide variation in the results obtained by the class, due to variations in the amount of care and attention which individuals give to their work; to various methods of manipulation (e. g., whether the flour, sugar, etc. are spooned into the cup or dipped into it, whether the spoonful is levelled off with a vertically placed or horizontally placed knife or spatula; to variations in the size of cups and spoons, variations which it is impossible to eliminate entirely, in utensils of moderate cost; to the physical condition of the food material measured (whether dry or moist, lumpy or uniformly comminuted, fine or coarse grained, lightly piled or well packed), as well as to variations in its chemical composition. A class study of the causes of these variations has, however, considerable educational value.

3. It may be worth while to try to arrive at some estimate as to results to be expected from individual differences in manipulation of dough. It would seem that two women using the same kind of flour, the same bread recipe, and making the same sized loaf, should obtain the same number of loaves from a given amount of flour, but this is not always the case; nor is it simply a matter of waste flour thrown away. One girl in a bread-making class will sometimes use almost 40% more flour (by actual weight) than her neighbor, to get a dough which is apparently of about the same stiffness; and the resulting loaf, though it weighs more, may not show expected differences in texture.

(The different liquids—whole milk, skim milk, and water—will of course vary somewhat as to the amount of flour they require.)

4. Some estimate should certainly be made for cost of fuel, where a gas stove is used. This will necessitate the presence of a meter in the food laboratory. In case a coal or wood range is used in the home, however, the bread-baking fire probably serves other purposes at the same time.

5. The cost of labor in home baking of bread is usually not

figured, as it does not ordinarily involve an extra outlay of money, but rather a shifting of work, so that it is done at the expense of other (presumably less important) tasks or at the expense of leisure time. It is important, however, to determine in any individual case just what this shifting is, and whether it can be wisely afforded, all individual and family interests having been considered.

The relative cost of the homemade loaf of bread, then, is seen to be a variant whose determining factors are numerous and often very complex in their relation with each other.

Recent discussions of this same subject are to be found in *Journal of Home Economics*, March, 1915, p. 165, and in *Housewives' League Magazine*, March 1915, p. 15.

HOME ECONOMICS QUESTION BOX.

HOUSEHOLD MANAGEMENT.

- I. Give a simple form for keeping personal and household accounts. Give form of check.
- II. What is a budget plan?
- III. How should an income of \$1,000, \$1,500, \$2,500 or \$5,000 be apportioned? Explain the chief differences.
- IV. Should there be a nearly regular system of work planned for each day? Why? Each week?
- V. Into what divisions may the work of the household be divided? Which takes the most time?
- VI. How may different members of the family help in the household work?
- VII. What labor saving devices should be in a moderately well-to-do household?
- VIII. What is the order of work in the thorough cleaning of a room? Explain why. What cleaning equipment is necessary for removing dust, cleaning paint, woodwork and glass?
- IX. What plumbing repairs should a housekeeper know how to make? What is the best way to keep plumbing clean and pipes open?
- X. Explain action of chief cleansing and purifying agents used in the laundry. Why must clothes be sorted?

HOUSE—TWO PERIODS A WEEK.

Second Year Domestic Science, High School.—Miss Chase.

- I. Name the different styles of architecture in their order. In each period which form of architecture was most thoroughly developed? Why?
- II. Name ten kinds of early habitations. What conditions governed their construction?
- III. Give five good points to consider in selecting a site for a house.
- IV. What points do you consider most important in designing a house?
- V. What are some of the common conventions of architectural drawings?
- VI. What is the use of sketches, floor plan and elevation, working drawing?
- VII. How does the Southern California climate affect building requirements?

- VIII. What should be considered in the selection of furnishings and furniture for a small house?
- IX. How may the problem of heating be solved in this locality? What are the late ideas on means of lighting and ventilation in kitchen, dining room, closets and bath room?
- X. Define meaning of *deed*, *quit claim deed*, *abstract of title*, *mortgage*, *city and county taxes*, *street assessment*, *building and loan association*, and *rent*.

REVIEW QUESTIONS.

First Year High School, Santa Barbara, Cal., Domestic Science.—Miss P. Chase.

- I. What sciences are closely correlated with the study of housekeeping, cooking, laundry and house-cleaning?
- II. What part does water play in cooking? In cleaning? What affects the rapidity or ease of solution of different substances? How may the amount of water in a food be determined roughly?
- III. Give simple tests for determining presence of C, H, O, N and S in substances.
- IV. Name the class of carbohydrates to which they belong and give physical characteristics and simple tests to distinguish starch, dextrin, cane sugar, lactose, grape sugar or dextrose. What is meant by hydrolysis of starch?
- V. What is the effect of heat upon—
 - (a) Starch in double boiler; over free flame?
 - (b) Albumin and casein in egg, milk, cheese, myosin in meat? Of moist and dry heat?
 - (c) Fat—in foods when used for deep frying? Explain especially the effect as regards digestibility of cooked food.
- VI. What are the sources, and use in the body of carbohydrate, fat, protein, water and mineral matter?
- VII. Classify and describe use of different leavening agents.
Name three classes of baking powders and their contents.
- VIII. Describe briefly the action of saliva on starch paste; and artificial gastric and pancreatic juice on cooked white of egg and minced meat.
- IX. Describe use of lactometer and microscopic and Babcock tests for milk.
- X. What is the preservative action of vinegar, spices, salt brine, sugar, bran, drying, sterilization?
Name kinds of food to which each is suitable.

SOME COMMON ERRORS HEARD IN HOME ECONOMICS CLASS ROOMS.

3. "One pint of whole milk *contains* 335 calories."

Now the calorie is no material substance which could be fished out of the milk; it is rather a measure of value. One would not say, "one pint of milk *contains* five cents"—if that be its price. A pint of milk *is worth* 335 calories, or *yields* 335 calories, or *will give* 335 calories' worth of energy to the body.

PROBLEM DEPARTMENT.

By I. L. WINCKLER,

Central High School, Cleveland, Ohio.

Readers of this magazine are invited to propose problems and send solutions of problems in which they are interested. Problems and solutions will be credited to their authors. Address all communications to I. L. Winckler, 32 Wymore Ave., E. Cleveland, Ohio.

Algebra.

426. Proposed by the Editor.

$$\begin{aligned}\text{Solve:} \quad & x(y+z-x) = a. & (1) \\ & y(z+x-y) = b. & (2) \\ & z(x+y-z) = c. & (3)\end{aligned}$$

I. Solution by Norman Anning, Clayburn, B. C., and L. C. Mathewson, Hanover, N. H.

From (1)+(2)-(3) we have

$$\begin{aligned}a+b-c &= xy+xz-x^2+yz+xy-y^2-xz-zy+z^2 \\ &= (z-x+y)(z+x-y)\end{aligned} \quad (3)$$

\therefore From (1), (2) and (3)

$$xy(a+b-c) = ab.$$

Similarly

$$yz(b+c-a) = bc.$$

$$zx(c+a-b) = ca.$$

$$\therefore xyz = \pm \frac{abc}{\sqrt{(a+b-c)(b+c-a)(c+a-b)}}$$

$$\text{But } yz = \frac{bc}{b+c-a}$$

$$\therefore x = \pm \frac{a(b+c-a)}{\sqrt{(a+b-c)(b+c-a)(c+a-b)}}$$

Similarly

$$y = \pm \frac{b(c+a-b)}{\sqrt{(a+b-c)(b+c-a)(c+a-b)}}$$

$$z = \pm \frac{c(a+b-c)}{\sqrt{(a+b-c)(b+c-a)(c+a-b)}}$$

II. Solution by James H. Weaver, West Chester, Pa.

Let $a = mx$, $b = ny$, $c = pz$.

$$\therefore y+z-x = m, \quad x-y+z = n, \quad x+y-z = p.$$

Adding these equations

$$x+y+z = m+n+p.$$

$$\text{Also} \quad x = \frac{n+p}{2}, \quad y = \frac{m+p}{2}, \quad z = \frac{m+n}{2}$$

$$\text{or} \quad \frac{n+p}{2} = \frac{a}{m}, \quad \frac{m+p}{2} = \frac{b}{n}, \quad \frac{m+n}{2} = \frac{c}{p}$$

$$\therefore mn+mp = 2a, \quad mn+np = 2b, \quad mp+np = 2c.$$

$$\text{Or } mn+np+mp = a+b+c.$$

$$\therefore mn = a+b-c. \quad (4)$$

$$mp = a-b+c. \quad (5)$$

$$np = b+c-a. \quad (6)$$

\therefore multiplying (4) by (5), dividing the result by (6), and extracting the square root

$$m = \pm \sqrt{\frac{(a+b-c)(a-b+c)}{b+c-a}}$$

$$\therefore x = \frac{a}{m} = \pm \frac{a\sqrt{b+c-a}}{\sqrt{(a+b-c)(a-b+c)}}$$

The values of y and z may be found in a similar manner. However when found care must be taken to pair the values properly.

Geometry.

427. *Proposed by Nelson L. Roray, Metuchen, N. J.*

Given a rectangle whose base is to its altitude as 5:1. Cut it into four parts so that they may be joined together to form a perfect square.

I. *Solution by the Proposer, and Vincent Scofield, West Chester, Pa.*

Let ABCD be the given rectangle, with $AB = 5AD$.

Take on AB, AE = 2AD. Draw DE. Draw EF \perp DE cutting DC at F. Draw CG \parallel EF.

Then ADE, DEF, EGCF, and GBC are the required parts as is easily proved.

Place EGCF so that EG coincides with DF and points E, F, G, C form a straight line. Place BC on AD. Then complete the square with the new triangle EDG.

II. *Solution by Norman Anning, Clayburn, B. C., and Garson Prenner, Syracuse, N. Y.*

Let KLMN be the given rectangle in which $KL = 5ML$.

Divide NM at P and R so that $NP = \frac{1}{5}NM$, $NR = \frac{4}{5}NM$.

Divide KL at Q and S so that $KQ = \frac{3}{10}KL$, and $KS = \frac{2}{5}KL$.

Then cuts along PQ, QR, RS divide the rectangle into four parts that can be arranged to form a square.

III. *Solution by Ida May Davis, Markesan, Wisconsin.*

Let ABEF be the rectangle with $BE = 5EF$.

On BE take $BC = \frac{1}{2}EF$, $CD = \frac{5}{2}EF$.

On AF take $AG = \frac{5}{2}EF$.

Draw AC, CG, and GD.

Then ABC, ACG, CGD, and GDEF may be placed together to form a square.

428. *Proposed by Henry B. Sanders, New York, N. Y.*

ABCD is a quadrilateral having $AB = AD$, and $\angle C = \angle B + \angle D$; prove $AC = AB$.

I. *Solution by Katherine Ramsey, Rockport, Mo.*

Describe a circumference with A as a center and AB as a radius. This will pass through D. Produce BA and DA to cut the circumference at B' and D', respectively.

Let BC intersect the circumference at K, and DC at K'.

Since $\angle A + 2\angle B + 2\angle D = 4\text{rt } \angle$ s,

Arc $\angle BKK' + \text{arc } KK'DB' + \text{arc } D'B' = 2\pi$.

or arc $D'B' + \text{arc } BK + \text{arc } KK' + \text{arc } KK'D + \text{arc } D'B' + \text{arc } B'D' = 2\pi$.

Also arc $D'B' + \text{arc } BK + \text{arc } KK' + \text{arc } K'D + \text{arc } DB' + \text{arc } B'D' = 2\pi$.

From these we have arc $KK' = 0$.

That is BC and CD cut the circumference at the same point. Therefore C lies on the circumference. $\therefore AC = AB$.

II. *Solution by Walter C. Eells, Annapolis, Maryland.*

Pass a circle through B, C, D, and extend AB and AD to cut it in E and F.

Then A is on a diameter of this circle, perpendicular to the chord DB, since $AD = AB$.

Since $\angle C = \angle B + \angle D$

$$\text{arc FBC} + \text{arc CDE} = \text{arc DEFB.}$$

$\therefore \text{arc BCD} = \text{arc EF.}$

$\therefore A$ is on another diameter perpendicular to the bisector of $\angle DAB$.

$\therefore A$ is at the center of the circle of construction and $AC = AB$, since they are both radii.

III. *Solution by Mabel G. Burdick, Stapleton, N. Y.*

Let AC divide angle C into the angles a and b , a being in triangle ABC.

Suppose $AC \neq AB$ and therefore $AC \neq AD$.

Then if $AC < AB$, $AC < AD$.

And $a > \angle B$, and $b > \angle D$.

$\therefore \angle C = a + b > \angle B + \angle D$.

Similarly if $AC > AB$, $\angle C > \angle B + \angle D$.

But this contradicts the hypothesis, therefore $AC = AB$.

429. *Proposed by N. P. Pandya, Sojitra, Dt. Petlad, India.*

Construct a triangle ABC, A being the point of contact of two given circles having an internal contact, BC a chord of the larger circle tangent to the smaller, and having given $AB : AC = m : n$.

[No complete solution of this problem has been received.]

Trigonometry.

430. *Proposed by Daniel Kreth, Wellman, Iowa.*

The perimeter of a triangle is 120, the radius of the inscribed circle 10, and the vertical angle 70° . Construct the triangle and determine the sides.

I. *Solution by H. C. McMillan, Kingman, Kansas, and Nelson L. Roray, Metuchen, N. J.*

Let A be given angle, r radius of incircle, K center of inscribed circle, K_1 center of escribed circle opposite angle A, Y and Y_1 the points of tangency of side AC with the incircle and escribed circle respectively.

From the equality of tangents to a circle from a given point it follows that

$$AY_1 = s.$$

$$AY = s - a = r \cot \frac{A}{2}$$

Hence the construction:

On side AC of given angle construct $AY = r \cot \frac{A}{2}$ and $AY_1 = s$.

At Y and Y_1 erect perpendiculars intersecting bisector of angle A in K and K_1 respectively, the centers of the inscribed and escribed circles respectively. Draw common internal tangents to these circles. They will intersect sides of angle A in required vertices.

If $\angle B \neq \angle C$, two solutions are given.

If $\angle B = \angle C$, the circles are tangent and internal tangents coincide.

To determine sides and angles

$$\frac{r}{s-a} = \tan \frac{A}{2}$$

$$\frac{10}{60-a} = 0.7002,$$

$$a = 45.7.$$

$$\frac{bc}{2} \sin A = \text{area of } \Delta = r \cdot s = 600,$$

$$\frac{.9397bc}{2} = 600.$$

$$bc = 1277.0.$$

$$2s-a = b+c = 74.3.$$

(1)

(2)

Solving (1) and (2)

$$b = 27.0 \text{ or } 47.3.$$

$$c = 47.3 \text{ or } 27.0.$$

$$\text{The altitude to side } a = \frac{2 \cdot 600}{45.7} = 26.7.$$

$$\sin B = \frac{26.7}{47.3} \text{ or } \frac{26.7}{27.0}$$

$$\therefore B = 33.6^\circ \text{ or } 76.4^\circ.$$

$$\sin C = \frac{26.7}{27.0} \text{ or } \frac{26.7}{47.3}$$

$$\therefore C = 76.4^\circ \text{ or } 33.6^\circ.$$

II. *Solution by T. M. Blakslee, Ames, Iowa, and L. E. A. Ling, La Grange, Ill.*

Using the formulas $r = \sqrt{\frac{(s-a)(s-b)(s-c)}{s}}$ and $\tan \frac{C}{2} = \frac{r}{s-c}$ we have

$$(60-a)(60-b)(60-c) = 6000, \quad \frac{10}{60-c} = .700. \quad \therefore C = 45.7.$$

$$s-c = 14.3, \quad (60-a)(60-b) = 419.6.$$

$$a+b = 74.3, \quad b = 74.3-a, \quad 60-b = a-14.3.$$

$$(a-14.3)(a-60) = -419.6.$$

$$\therefore a = 47.25 \text{ or } 27.02 \text{ and } b = 27.02 \text{ or } 47.25.$$

Hence the sides are 47.25, 27.02, and 45.7 from which the triangle may be constructed.

CREDIT FOR SOLUTIONS.

422. Mabel G. Burdick, Ella M. Richards, Yeh Chi-Sun. (3)
 425. Mabel G. Burdick, Garson Prenner. (2)
 426. Norman Anning, James A. Bell, C. A. Hahn, J. O. Hassler, William W. Johnson, Thos. J. Leslie, L. C. Mathewson, J. O. Osborn, Garson Prenner, Nelson L. Roray, James H. Weaver. (11)
 427. Norman Anning, Ida May Davis, H. C. McMillan, J. O. Osborn, Garson Prenner (2), Nelson L. Roray, Vincent Scofield. (8)
 428. T. M. Blakslee, Mabel G. Burdick, Walter C. Eells, Thos. J. Leslie, H. C. McMillan, J. O. Osborn, Claude O. Pauley, Garson Prenner, Katherine Ramsey, Nelson L. Roray, Herbert Wharton, two incorrect solutions. (13)
 430. T. M. Blakslee, L. E. A. Ling, H. C. McMillan, Nelson L. Roray. (4)
 Total number of solutions, 37.

PROBLEMS FOR SOLUTION.

Algebra.

436. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

$$\begin{array}{ll} \text{Solve:} & \begin{cases} 2xy = 32 - 4x + y. & (1) \\ 3yz = 94 - y - 6z. & (2) \\ 6zx = 81 + 3z - 2x. & (3) \end{cases} \end{array}$$

Geometry.

437. *Proposed by H. C. McMillan, Kingman, Kansas.*

Given two points on the same side of a straight line. Construct the maximum angle having its vertex on the given line and its sides passing through the given points.

438. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Construct a circle that shall be tangent to a given straight line and co-axial with two circles that are non-intersecting and not tangent.

Trigonometry.

439. *Proposed by Norman Anning, Clayburn, B. C.*

AV and BV are two straight lines which differ in direction by an angle $\phi_1 + \phi_2 + \phi_3$. The points A and B are joined by a "three-center compound," i. e., a smooth curve consisting of three circular arcs and having VA and VB as tangents. If starting from A, the radii and central angles, are, respectively, $R_1, \phi_1; R_2, \phi_2; R_3, \phi_3$; show that $VB \sin(\phi_1 + \phi_2 + \phi_3) = R_1 + (R_2 - R_1) \cos \phi_1 + (R_3 - R_2) \cos(\phi_1 + \phi_2) - R_3 \cos(\phi_1 + \phi_2 + \phi_3)$.

440. *Proposed by Nelson L. Roray, Metuchen, N. J.*

If b, c, B are given, and there are two triangles with these given parts, show that their inscribed circles touch if

$$c^2(\cos^2 B + 2\cos B - 3) + 2bc(1 - \cos B) + b^2 = 0.$$

SCIENCE QUESTIONS.

BY FRANKLIN T. JONES,

University School, Cleveland, Ohio.

Readers of SCHOOL SCIENCE AND MATHEMATICS are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.

Questions and Problems for Solution.

186. *Proposed by W. L. Baughman, East St. Louis, Ill.*

Find the depth of a mine at the bottom of which a seconds pendulum loses 9 seconds a day.

187. *From folder of Gray Motor Company, Detroit, Mich.*

What power will be required to drive a boat 20 ft. long, 52 in. beam, at 11 miles per hour?

188. *From Scientific American Correspondence.*

Why in very cold weather are meat or vegetables more likely to freeze in a refrigerator car or refrigerator containing no ice than in one supplied with ice?

The following examination in *Physical Science* was given by Harvard College in June, 1887. It is the first of the series of examination questions which have exerted such a powerful influence on Science teaching in America.

A. 1. Which could you throw farther, a solid iron sphere 1 in. in diameter, or a solid wooden sphere of the same size? Tell as exactly as you can why this is so.

2. a. The horizontal reach of a certain inclined plane is 8 ft., its height is 6 ft.; its length, therefore, is 10 ft. A force applied parallel to the incline draws a mass of 100 lbs. from the bottom to the top. How great a force is required and how much work does it do (disregard friction).
Or b. A ball is sent vertically upward with a velocity of 80 ft. per sec. What will be its height above the starting point after 4 sec.?

3. What reasons have you for believing sound to be a wave motion of air?

4. What point on the Fahrenheit scale of temperature corresponds to 20° on the centigrade scale?

How would you test the accuracy of the freezing point and boiling point of a thermometer?

5. a. Explain by means of a diagram the action of a convex lens used as a "simple microscope," i. e., to give a magnified and erect image of an object. Where must the object be placed with respect to the principal focus of the lens?

Or b. Describe the construction and action of a Nicol prism.

6. a. Describe very carefully and fully the construction and action of the electrophorus.

Or b. Describe very carefully and fully the process of electrotyping with copper.

B. 1. Define "plane of the ecliptic."

What is a solar day? mean solar day? sidereal day?

2. Define nebula, constellation, milky way. What reason have we for thinking the "fixed stars" to be much farther from us than the sun is?

C. [Part C will be published in a later issue.]

Solutions and Answers.

173. *Proposed by W. L. Baughman, E. St. Louis, Ill.*

One arm of a balance is 9 inches long and the other is 10 inches. Show that if one weighs the substance to be sold as often on one scale pan as on the other he loses $\frac{1}{10}$ of the transaction.

Solution by Roy E. Jensen, Belle Vernon, Pa.

When goods to be sold are weighed on short arm it will take $\frac{10}{9}$ of a lb. to balance a lb weight while if weighed on the long arm it will take $\frac{9}{10}$ of a lb., according to the law of moments. \therefore when a man sells two lbs. of goods according to the scale he really sells $\frac{18}{10}$ lbs. real weight. His loss is therefore $\frac{18}{10} - 2 = \frac{1}{10}$ on 2 lbs. \therefore the per cent of loss = $\frac{1}{10}\%$.

Also solved by A. Haven Smith, Riverside, Cal.; R. W. Boreman, Parkersburg, W. Va.; Niel Beardsley, Bloomington, Ill.; Thos. J. Leslie, University, Ala.

174. *From a Columbia University Entrance Examination.*

How much force is required to pull a sled weighing 200 lbs. up a hill

rising 1 foot in 5 feet along the incline, neglecting friction?

How much work is done in pulling the sled 200 feet along the incline?

Solution by Carrie Mikesell, Greenville, Ohio.

The formula for finding the acting force is:

Acting force, F : weight, F' : : height, h , of plane : length l .

In this case

$$F : 200 : : 1 : 5.$$

$$5F = 200.$$

$$F = 40 = \text{lbs. of force required.}$$

Work done = force acting \times distance passed over.

$$= 40 \times 200 = 8000 \text{ ft. lbs.}$$

Also solved by W. L. Baughman, Niel Beardsley, J. Irl Cormany, Ramona, Okla.; Roy E. Jensen, Thos. J. Leslie, A. Haven Smith.

175. *From a Columbia paper.*

A homogeneous beam of constant cross-section has a length of 20 ft. and weighs 75 lbs. The beam is supported at the ends A and B. What will be the force on each support if a weight of 100 lbs. is hung 3 feet and a weight of 150 lbs. at 8 feet from the end A?

Solution by J. Irl Cormany, Ramona, Okla.

Total weight of beam or 75 lbs. would be equally supported by A and B, making 37.5 lbs. at each point.

By formula: Power : weight = weight arm : power arm.

100 lbs. hung 3 feet from A would be divided between A and B in the ratio of 17 to 3.

A would receive $17\frac{1}{20}$ and B $3\frac{1}{20}$ of 100 lbs.

\therefore A would receive 85 lbs. and B 15 lbs.

150 lbs. hung 8 feet from A would be divided between A and B in the ratio of 12 to 8.

A would receive $12\frac{1}{20}$ and B would receive $8\frac{1}{20}$ of 150 lbs.

\therefore A would receive 90 lbs. and B would receive 60 lbs.

Total on A = 37.5 plus 85 plus 90 or 212.5 lbs.

Total on B = 37.5 plus 15 plus 60 or 112.5 lbs.

Also solved by W. L. Baughman, Niel Beardsley, R. E. Jensen, Thos. J. Leslie, Carrie Mikesell, A. Haven Smith.

176. *From a Columbia paper.*

If one cubic meter of air weighs 1.3 kilograms, and one cubic meter of illuminating gas weighs 0.80 kilograms, what volume of illuminating gas will be needed to cause a balloon to rise, if the balloon weighs 100 kilograms when empty?

Solution by Thos. J. Leslie, University, Ala.

One cubic meter of illuminating gas is buoyed up by the air by a force equal to 1.3 kg. - 0.80 kg. = .5 kg.

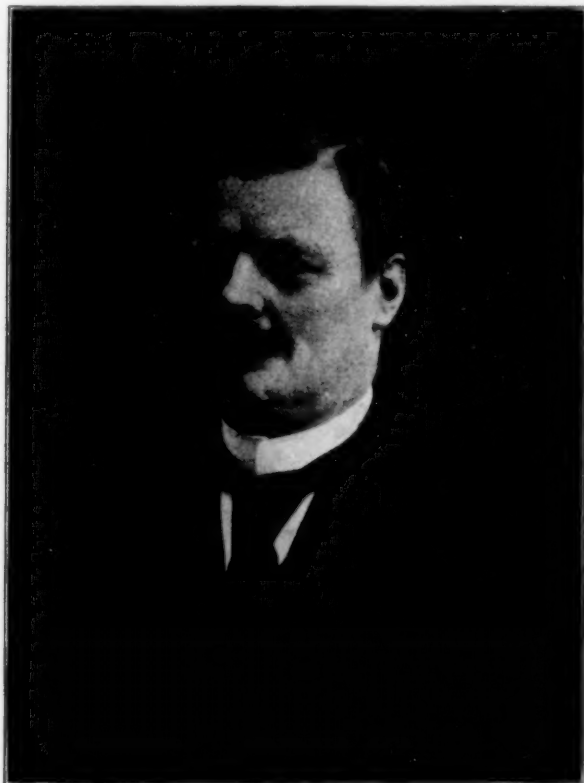
One cubic meter has a lifting force of .5 kg. To lift 100 kg. requires $100 \text{ kg} \div .5 \text{ kg} = 200$, number of cubic meters of illuminating gas needed.

NOTE by R. E. Jensen: If a balloon was made of material which would not stretch it would require more gas for the air is not homogeneous and therefore gets lighter as the balloon ascends and would not have the same bouyant effect.

Also solved by W. L. Baughman, Niel Beardsley, J. Irl Cormany, Carrie Mikesell.

RESOLUTIONS.

At the seventieth meeting of the Eastern Association of Physics Teachers, held in the high school at Medford, Mass., on March 20, 1915, the following resolutions were passed:



ERNST GRIMSEHL.

Whereas, The Eastern Association of Physics Teachers has recently learned of the untimely death of one of its most highly esteemed foreign correspondents, Professor Ernst Grimsehl, Director of the Ober real schule auf der Uhlenhorst in Hamburg, be it therefore

Resolved:

First, That we express our deep appreciation of Professor Grimsehl, as a rarely gifted inventor of physical apparatus, as an inspiring and sympathetic teacher of boys and fellow teachers, as an accomplished and efficient school director, and as an indefatigable and illuminating author.

Second, That we hereby express our profound sympathy with his family in the sad and irreparable loss which they have sustained.

Third, That these resolutions be entered on the minutes of this Association, that a copy be sent to his family, and that a copy for publication be sent to SCHOOL SCIENCE AND MATHEMATICS and to the *Zeitschrift für den Physikalischen und Chemischen Unterricht*.

INDIANA ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS.

The twentieth annual meeting of the Indiana Association of Science and Mathematics Teachers was held Friday and Saturday, March 5th and 6th in the city of Indianapolis. The first meeting was held Friday afternoon in Caleb Mills Hall at Shortridge High School with President Frank B. Wade, presiding. Professor George Buck, Principal of Shortridge High School, welcomed the Association to the city. After the response of the President, Mr. Ricards of the Eli Lilly Drug and Chemical Company gave an interesting lecture on "Some Practical Applications of Biology."

The evening session was held in room 30 Shortridge High School at 7:45 o'clock. The President appointed the following committees:

Committee on Nominations—Dr. W. M. Blanchard, Greencastle, Ind., Chairman, Mr. Wm. E. Pearson, La Fayette, Ind., and Professor R. F. Ratlaff, Danville, Ind.

Auditing Committee—B. D. Neff, Indianapolis, Ind., Chairman, Ralph S. Powers, Terre Haute, Ind., and M. M. Jones, Lebanon, Ind.

The evening lecture was given by Dr. W. W. Blanchard of Depauw University on "Some European Impressions." This lecture was illustrated with the lantern.

The general business meeting was held in the teachers' room of Shortridge High School Saturday morning at 8:30 o'clock. After the general routine of business the chairman of the Nominating Committee reported nominations as follows:

President—Wm. R. Hardman, Anderson, Ind.

Vice-President—M. M. Jones, Lebanon, Ind.

Secretary-Treasurer—E. S. Tillman, Hammond, Ind.

Chairman Executive Committee—Charles E. Montgomery, Bloomington, Ind.

Member of Executive Committee—Miss Maude Campbell.

This report was adopted and the officers declared elected. At the request of Professor J. A. Randall, Brooklyn, N. Y., President of the Science Department of the National Educational Association, Mr. B. W. Kelly of Richmond, Ind., was appointed as the Indiana member of the Science Council of the N. E. A. It is understood that this council is instructed with the work of establishing permanent activities in a way to survive the varying aims and interests of the annually changing roster of officers. The Executive Committee was instructed to have the next meeting at Indianapolis in October, at which time the State Teachers Association holds its annual meeting. That is, our Indiana Association of Science and Mathematics Teachers would affiliate but not unite with the State Teachers' Association. This was done to give more teachers an opportunity to attend the sessions since the state law requires that teachers be paid for attendance at the October sessions of this meeting.

The sectional meetings were held as follows:

PHYSICS AND CHEMISTRY.

Prof. R. F. Ratliff, Central Normal College, Chairman.

Mr. O. I. Bandeen, Noblesville High School, Secretary.

"Some Recent Types of Electric Lights"—Mr. Harold Blair, Shortridge High School.

"Copper Mines of Lake Superior"—Mr. J. F. Thompson, Richmond High School.

"Rationalizing Grades"—Mr. E. Vernon Hahn, Shortridge High School.

MATHEMATICS SECTION.

Prof. E. N. Johnson, Butler College, Chairman.

Mr. Claude E. Kitch, Manual Training H. S., Secretary.

"Some Deficiencies in Mathematical Training"—Prof. S. C. Davisson, Indiana University.

"The Scope and Place of Arithmetic in the High School"—Mr. D. W. Werremeyer, Fort Wayne High School.

"Some of the Problems of the Inexperienced Mathematics Teacher"—Miss Mabel Bonsall, Indiana State Normal School.

BIOLOGY SECTION.

Mr. M. M. Jones, Lebanon High School, Chairman.

Mr. Wm. E. Pierson, Lafayette High School, Secretary.

"Plant Chimeras and their Relation to Hereditary Phenomena"—Illustrated with Lantern—Prof. D. M. Mottier, Indiana University.

"The Status of Botany and Zoölogy Teaching in Indiana"—Mr. Charles E. Montgomery, Bloomington High School.

"A Piece of Research Work at a Seashore Laboratory"—Prof. Raymond Binford, Earlham College.

NOTE: Time will be given for questions and discussion at the close of each paper.

EXCURSIONS.

Trip to Power Plant of T. H. I. & E. Traction Co.—Led by Mr. Blair, Shortridge High School.

Trip to By-Product Coke Oven Plant of Citizens Gas Co.—Led by Mr. Wade.

The most of these papers are available for publication in the magazine, making further discussion of the program unnecessary.

ERNEST S. TILLMAN,
Secretary-Treasurer.

MATHEMATICS CONFERENCE—MICHIGAN SCHOOLMASTERS' CLUB, ANN ARBOR.

Chairman—Professor L. C. Karpinski, University of Michigan.

Secretary—Mr. E. F. Gee, Detroit.

12:45 o'clock—Get-together luncheon, Thursday, April 1st, at Newberry Hall Tea Room.

PROGRAM.

2:00 o'clock, Thursday, Newberry Hall:

"Practical Problems"—W. H. Pearce, State Normal College.

"Practical Problems"—H. M. Keal, Cass Technical, Detroit.

"Practical Problems"—Wm. Prakken, Highland Park.

"Practical Geometry"—Miss M. L. Welton, Grand Rapids.

"Practical Arithmetic and Algebra"—R. M. Sprague, Toledo.

"Correlation, Arithmetic and Algebra"—M. O. Tripp, Olivet.

"Correlation, Algebra and Geometry"—Miss M. C. Woodward, Detroit Western.

"Correlation, Physics and Mathematics"—A. Darnell, Detroit Central.

"Correlation, Mathematics and Agriculture"—L. C. Plant, M. A. C.

2:00 o'clock, Friday afternoon, Tappan Hall:

"Practical Problems in Geometry"—S. A. Courtis, Detroit.

"Teaching of Algebra"—E. R. Sleight, Albion.

"Teaching of Algebra"—L. P. Jocelyn, Ann Arbor.

"Some Mistakes in the Teaching of Geometry"—Mrs. Florence Milner, Detroit University School.

"Class Room Methods in Geometry."—Miss Helen Wattles, Detroit Central.

"Teaching of Geometry"—L. D. Wines, Ann Arbor.

About eighty-five teachers of mathematics and allied sciences were present at the mathematics luncheon of the Michigan Schoolmasters' Club. It is proposed to make the luncheon an annual affair, as it served to enable all to get acquainted and to exchange experiences in private conversation. The papers at this session were devoted entirely to practical phases of the teaching of high school mathematics. Correlation and real problems occupied a prominent place in the discussion.

Particular interest was aroused by the description by Mr. Keal of the continuation work in the Cass Technical High School of Detroit. A number of factories in Detroit are paying their men full time for two or more afternoons per week, put in on applied school work in this high school. Miss Mary Welton of Grand Rapids had an exhibit of drawings, in connection with practical geometry. Not only was mechanical drawing emphasized, but also perspective work in black and white, to illustrate the theorems of solid geometry.

Mr. R. M. Sprague of Toledo gave an interesting account of the work being done with "over-size" boys in the Toledo schools. By correlation with manual training and practical work these boys make rapid progress in arithmetic and elementary algebra, in the seventh and eighth grades. In this way a majority go on into the high school proper.

At the following meeting, next April, it is proposed to continue the discussion of real problems in high school work, and also to discuss the relation of the various phases of higher mathematics to the elementary mathematics.

E. F. GEE, *Secretary*.

COMICAL SAYINGS IN THE CLASS ROOM.

If we are able to secure from our readers unique and comical sayings or statements which have occurred in the classroom, we shall publish from time to time a page or two of this matter. We are asking, therefore, that our readers send to the Editor copy of sayings of this nature which have occurred during their teaching experience.

AN INTERESTING EXPERIMENT ON INTERFERENCE OF LIGHT WAVES.

BY JAMES A. COSS,

Morningridge College, Sioux City, Iowa.

Sift a light film of lycopodium powder over a plate of glass and hold the plate about two feet from the eye and about fifteen feet from a small source of light, such as a candle or electric light. The particles of the powder will cause interference of the light and form a series of concentric rings of the prismatic colors of light.

This is a good example of interference of light waves for a class in Physics, and may be used to show the condition of the atmosphere when a corona or ring appears around the sun or moon before a storm.

Attempts to produce the effect by means of flour, chalk dust, fine fuller's earth, zinc dust, iron filings, aluminium powder, and flowers of sulphur failed. Examination of the materials with a microscope showed the particles to be irregular in all of these materials, besides they could not be distributed evenly on the glass. The particles of the lycopodium powder are globular in shape and can be distributed quite regularly over the glass.

NEW YORK STATE TEACHERS ASSOCIATION.

The annual meeting was held at Syracuse, Dec. 28-30, 1914. At the business session the following reports were made:

The Committee on Revision of the Syllabus in Physics and in Chemistry offered their report and suggested the following for adoption by the New York State Board of Regents.¹

The following resolution was then moved: "RESOLVED, That the reports on Syllabus revision in Physics and in Chemistry be adopted." Motion carried.

The report of the Secretary-Treasurer is as follows:

Received from former Treasurer.....	\$ 57.31
Received from Class A Members.....	188.00
Received from Class B Members.....	123.00

\$368.31

EXPENDITURES.

For expense of 1914 meetings.....	\$ 67.54	
Printing, 1915	33.15	
Postage, 1915	37.20	
Clerk hire	15.20	
SCHOOL SCIENCE AND MATHEMATICS.....	76.50	
Express	2.99	
Telegrams	1.31	
American Society of Mechanical Engineers.....	5.00	
Biology Section meeting, 1915	1.14	
Signs for 1915 meeting.....	5.30	
Mack Lumber Co.	14.39	
Associated Academic Principles (programs)	5.14	
Rent of Moving Picture Hall.....	10.75	
Thumb tacks for exhibit.....	3.00	
Tar paper for exhibit	3.02	
Labor	14.33	
SCHOOL SCIENCE AND MATHEMATICS.....	72.00	\$367.96

Balance \$.35

E. F. CONWAY, *Sec.-Treas.*

The above accounts and vouchers were examined and found to be correct by the Auditing Committee.

The report of the Secretary-Treasurer was accepted and ordered placed on file.

The Committee on Resolutions submitted the following:

The New York Science Teachers' Association desires to express its appreciation and thanks to all who have contributed to its comfort, pleasure and profit during the meetings just held.

Especially do we extend our thanks to the city of Syracuse for its welcome; to the press of the city for its interest in the publication of the activities of the various meetings; to the Solvay Process Company for its courtesy in permitting us to inspect its plant; to the School Board for the use of the rooms and equipment for our meetings; to the teachers of the high school who have given so unsparingly of their time and energy that we might have ample facilities for the carrying out of our program; and to those who have added to our enjoyment and profit by their addresses, exhibits, etc.

¹See printed copies.

Our thanks are due the officers of the Association for their untiring work in making this meeting a success. We have had pleasure and profit, they have had the work and anxiety of planning and executing the work of the Association.

G. T. HARGITT.

O. C. KENYON.

L. E. JENKS.

It was moved and unanimously carried that the report be adopted.

The Committee on Nominations submitted the following report:

For President—Bryan O. Burgin of Albany.

For Vice-President—Ernest F. Conway, Syracuse.

For Secretary-Treasurer—Harry A. Carpenter, Rochester.

Members of Council (terms of office to expire 1918)—C. N. Cobb, Albany; D. A. Cady, Elmira; G. M. Turner, Buffalo.

C. B. HERSEY,

F. P. HUESTED,

C. O. BEAMAN,

Nominating Committee.

This report was unanimously adopted.

ARTICLES IN CURRENT PERIODICALS.

American Forestry for April; *Washington, D. C.*; \$3.00 per year, 25 cents a copy: "Foresters in the German Army" (With three illustrations), T. R. Helms; "Uncle Sam in the Movies" (With thirteen illustrations), C. J. Blanchard; "Forests and Recreation" (With six illustrations), Warren H. Miller; "Bombardment of Papeete" (With six illustrations), A Tahitian of High Rank; "Chinese Trees Do Well Here" (with four illustrations); "Jamestown 100 Acre Lot" (with four illustrations); "Woodlot Forestry" (with four illustrations), S. B. Detwiler.

American Journal of Botany for March; *Brooklyn Botanic Garden*; \$4.00 per year, 50 cents a copy: "Morphology as a Factor in Determining Relationships," J. M. Greenman; "The Genetic Relationship of Parasites," Frank Dunn Kern; "The Experimental Study of Genetic Relationships," H. H. Bartlett.

American Mathematical Monthly for March; 5548 *Kenwood Ave., Chicago*; \$2.00 per year: "History of Zeno's Arguments on Notion, IV," Florian Cajori; "General Formula for the Valuation of Securities," J. W. Glover; "Questions and Discussions."

American Naturalist for April; *Garrison, N. Y.*; \$4.00 per year, 40 cents a copy: "Origin of Single Characters as Observed in Fossil and Living Animals and Plants," Dr. Henry Fairfield Osborn; "The Infertility of Rudimentary Winged Females of *Drosophila Ampelophila*," T. H. Morgan.

Condor for March-April; *Eagle Rock, Los Angeles Co., Calif.*; \$1.50 per year, 30 cents a copy: "Adaptability in the Choice of Nesting Sites of Some Widely Spread Birds" (with three drawings by the author), Clarence Hamilton Kennedy; "Nesting of the American Osprey at Eagle Lake, California" (with four photos), Milton S. Ray; "Notes on Murrelets and Petrels" (with three photos by L. Huey and A. Hiller), Adriaan van Rossem; "Birds of a Berkeley Hillside" (with fourteen photos on seven figures), Amelia Sanborn Allen; "A Forty Acre Bird Census at Sacton, Arizona," M. French Gilman; "Some Park County, Colorado, Bird Notes" (with two photos), Edward R. Warren.

Educational Psychology for March; *Warwick and York, Baltimore*; \$2.50 per year, 30 cents a copy: "The Importance of Social Status as Indicated by the Results of the Point Scale Method of Measuring Mental Capacity," Robert M. Yerkes and Helen M. Anderson; "A Psychological Study of Bright and Dull Pupils," W. H. Pyle; "The Value of Mental

Ages Tests for First Grade Entrants," Vinnie Crandall Hicks; "The Measurement of Efficiency in Spelling, and the Overlapping of Grades in Combined Measurements of Reading, Writing and Spelling," Daniel Starch.

Journal of Geography for April; *Madison, Wis.*; \$1.00 per year, 15 cents a copy: "The Geography of Tennessee," W. M. Gregory; "The Cascade Mountains," Minna J. Telker.

Journal of Home Economics for April; *Baltimore, Md.*; \$2.00 per year, 25 cents a copy: "The Visiting Housekeeper," M. Adelaide Nutting; "Instructive Inspection," Ellen H. Richards; "The Work of the Visiting Housekeeper," Frances Stern; "The Hiram House Model Cottage; A Social Settlement," Laura Gifford; "A Girls' Trade School Course in Dressmaking," Mary H. Scott; "Pottery Glazes and Their Solubility," C. F. Langworthy; "Indoor Humidity," L. R. Ingersoll.

Mathematical Gazette for March; *G. Bell & Sons, Portugal St., Kingsway, London*; 6 nos. 9s. per year, 2s. 6d. a copy: "Presidential Address: Mathematics in Artillery Science," Sir George Greenhill; "The Teaching of Modern Analysis in Secondary Schools," W. P. Milne; "Laboratory Work in Connection with Mathematics," R. C. Fawdry; "An Elementary Method of Finding Circles of Curvature," A. Lodge; "Mathematical Notes."

Nature-Study Review for April; *Ithaca, N. Y.*; \$1.00 per year, 15 cents a copy: "The Nesting of the Black Tern," Charles Knapp Carpenter; "Feed the Birds in Winter," Susan B. Sipe; "Recording Bird Music," Henry Oldys; "A House Wren's Day," Gilbert H. Trafton; "Bird Records"; "List of Birds Found within Twenty Miles of Chicago"; "Bird Study Northern Ill. State Normal School," Jessie R. Mann; "Some Common Mosses," A. J. Grout.

Photo Era for April; 383 *Boylston St., Boston*; \$1.50 per year, 15 cents a copy: "The Grain of Negatives," E. J. Wall, F. R. P. S.; "One Lens for Many Purposes," Phil M. Riley; "Making Improved Negatives by Photographing Enlargements," P. K. Turner; "The Enlarging-Lantern for Making Slides," E. Murray; "Beauty Among the Ordinary Things of Nature," William Armbruster; "Interiors in Natural Colors by Reflected Light," H. F. Perkins, Ph. D.; "Photograph the Baby," Albert B. Niess.

Physical Review for March; *Ithaca, N. Y.*; \$6.00 per year; 60 cents a copy: "A Method of Determining the Radiant Luminous Efficiency of a Light Source by Means of a Cell whose Transmission Curve is Identical with the Luminosity Curve of the Average Eye," Enoch Karrer; "Theory and Use of the Molecular Gauge," Saul Dushman; "Flicker Photometer Measurements by a Large Group of Observers on a Monochromatic Green Solution," Herbert E. Ives and E. F. Kingsbury; "Isolated Crystals of Selenium of the Second and Fifth Systems and the Physical Conditions Determining their Production," F. C. Brown; "The Intensities of X-Ray Spectra," David L. Webster; "Some Secondary Effects from Roentgen Rays," Paul T. Weeks; "A New Hydrometer of Total Immersion with Electro-magnetic Compensation," Anders Angstrom; "Signal Propagation in Dispersive Media," Walter Colby.

Popular Astronomy for May; *Northfield, Minn.*; \$3.50 per year, 35 cents a copy: "Astronomy on the Pacific Coast," Russell T. Crawford; "Graphical Illustration of Stellar Parallaxes," Frederick Slocum; "The Spell of the Southern Star," Ada Wilson Trowbridge; "Report on Mars, No. 9," William H. Pickering.

Popular Science Monthly for April; *Garrison, N. Y.*; \$3.00 per year, 30 cents a copy: "American Economic and Social Problems Arising out of the War," fifteen phases by as many authors; "A History of Tohiti," Alfred G. Mayer.

School World for April; *Macmillan Company, London, Eng.*; 7s. 6d. per year, 6d. a copy: "School Examinations. I. External, with Special Reference to Circular 849," Walter Rippmann; "Descriptive Geography of the War Area," J. Hamilton Birrell; "Decimals and the Decimal System in English Schools. I," S. Lister; "The Age of Transfer from the

Elementary to the Secondary School," A. Headmaster; "Science in the Daily Press," R. A. Gregory; "Our Wheat Supplies," B. C. Wa'lis.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht Aller Schulgattungen for April; B. G. Teubner, Leipsic, Germany; 12 nos. M. 12 per year: "Gustav Holzmüller," Dir. Prof. Dr. Wilhelm Lorey; "Photogrammetrie in der Schule," Oberl. Dr. P. Riebesell; "Konvexe pseudoreguläre Polyeder," Prof. Dr. O. Rausenberger; "Ueber die Ellipse. Neue Konstruktionen des Ellipsenkurve, ihres Tangenten und Durchmesser," J. Arneberg; "Konstruktionen in begrenzter Ebene mit Hilfe räumlicher Betrachtungen," A. Da Fano.

EARTHENWARE.

Chemists and chemistry teachers will be interested to learn that at last chemical laboratory porcelain is being made in this country. Conditions due to the European war have made it possible for an American firm to undertake the manufacture of chemical laboratory porcelain.

The Guernsey Earthenware Company, of Cambridge, Ohio, the largest manufacturer of earthenware cooking utensils in the world, have taken up this line; and now royal porcelain casseroles, crucibles, evaporating dishes, and mortars of a very high grade can be obtained "made in the U. S. A." The Guernsey trade-mark stands back of every piece, guaranteeing satisfaction and service equal to any porcelain made in the world. Write them for their catalog A.

MERRIAM-WEBSTER DICTIONARIES.

One of the best dictionaries for school, business, and home use, is without question the Merriam-Webster. No one making a purchase of one of these volumes will ever have reason to regret it. A remarkable and interesting statement that may be made truthfully with reference to this particular book, is that nearly every state in the union has adopted it for use in the schools. Teachers find it to be the dictionary that contains the words and derivatives with which they wish their pupils to become familiar.

Crushed stone is the largest factor of the stone industry in the United States. Figures showing the value of crushed stone were first published by the United States Geological Survey in 1898 and amounted to \$4,031,445. By 1913 the output was valued at over \$31,000,000. Of late years stone crushed for concrete making has largely taken the place of building and foundation stone.

BOOKS RECEIVED.

The common Law and the Case Method in American University Law Schools. A Report to the Carnegie Foundation for the Advancement of Teaching, by Professor Dr. Josef Radlich, University of Vienna. Pages xiii+84. 18.5x25.5 cm. Paper. 1914. 576 5th Ave., New York City.

Physics Laboratory Manual, Revised Edition, by Angus L. Cavanagh, Clyde M. Wescott, and Harry L. Twining, Los Angeles, Cal., High Schools. Pages v+60. Paper. 1915. Ginn & Co., Chicago.

Die Grundlagen der Psychologie, Von Theodor Ziehen. I. Buch: Erkenntnistheoretische Grundlegung der Psychologie. 260 S. 8. 1915. Geh. M. 4.40, in Leinwand geb. M. 5. II. Buch: Prinzipielle Grundlegung

gung der Psychologie. 304 S. 8. 1915. Geh. M. 4.40, in Leinwand geb. M. 5. Verlag von B. G. Teubner in Leipzig und Berlin.

Biologisches Praktikum für Höhere Schulen, Von Professor Dr. Bastian Schmid, Oberlehrer am Realgymnasium zu Zwickau. Zweite, Stark Vermehrte und Verbesserte Auflage mit 93 Abbildungen im Text und 9 Tafeln. 1914. Geheftet M. 2, in Leinwand gebunden M. 2.50. Verlag von B. G. Teubner, Leipzig und Berlin.

Elementary Algebra, A Complete Shorter Course, by W. H. Williams, Williams College, and W. B. Kempthorne, University of Wisconsin. Pages vi+481. 13.5x19.5 cm. Cloth. 1914. Lyons and Carnahan, Chicago. The School Kitchen Textbook, by Mary J. Lincoln. Pages xi+308. 13x18.5 cm. Cloth. 1915. 60 cents. Little, Brown & Co., Boston.

First Course in Chemistry, by Wm. McPherson and Wm. E. Henderson, Ohio State University. Pages x+416. 13.5x19.5 cm. Cloth. 1915. \$1.25. Ginn & Co., Boston.

Plane Geometry, by John H. Williams, High School, Urbana, O., and Kenneth P. Williams, Indiana University. 264 pages. 13½x19¼ cm. Cloth. 1915. Lyons & Carnahan, Chicago.

Social Evolution, by Albert G. Keller, Yale University. Pages ix+338. 14x19.5 cm. Cloth. 1915. \$1.50. The Macmillan Co., New York.

Elementary Textbook of Economic Zoology and Entomology, by Vernon L. Kellogg and Rennie W. Doane, Stanford University. Pages x+532. 13.5x19.5 cm. Cloth. 1915. Henry Holt & Co.

A Spring Flora for High Schools, by Henry C. Cowles and John G. Coulter. 144 pages. 12.5x18.5 cm. 1915. American Book Co.

Plant Life and Plant Uses, by J. G. Coulter, with Spring Flora by Cowles and Coulter. Pages 464+144. 12.5x18.5 cm. 1913. American Book Co.

Practical Course in Botany, by E. F. Andrews, with Spring Flora by Cowles and Coulter. Pages 374+144. 14x20.5 cm. 1911. American Book Co.

BOOK REVIEWS.

The Arithmetic Mean as Approximately the Most Probable Value a Posteriori Under the Gaussian Probability Law, by E. L. Dodd, University of Texas. Pages 20. 16x23 cm. Paper. 1915. Bulletin of the University of Texas.

The purpose of this paper is to harmonize as far as possible the principle of the arithmetic mean and the Gaussian probability law, viewed from the standpoint of probability *a posteriori*.

In the first section the notion of probability *a priori* is developed in descriptive fashion, and certain definitions and postulates are given and certain fallacies mentioned. Following this is a formal statement and proof of four theorems, involving various hypotheses concerning the *a priori* probability. The next section is on defective hypotheses, those which are inadequate to bring the Gaussian law and the arithmetic mean into close relation.

H. E. C.

The Common Law and the Case Method in American University Law Schools, a Report to the Carnegie Foundation for the Advancement of Teaching, by Professor Dr. Josef Radlisch, University of Vienna. Pages xiii+84. 18.5 x 25.5 cm. Paper. 1914. 576 5th Ave., New York City.

This latest bulletin of the Carnegie Foundation differs from the preceding bulletins in a marked degree, in that it reports on a phase

of educational work in the United States which heretofore has not been investigated by this Foundation. The report is made by a person who is abundantly equipped from all points of view to write on the subject with perfect understanding. The volume will be of the greatest service and interest to all who are interested in legal matters. There is a splendid index of eight pages appended. C. H. S.

Annual Report of the Board of Regents of the Smithsonian Institution, for 1913. Pages xi+804. 15x23.5 cm. Cloth. Government Printing Office, Washington, D. C.

This is another edition of these splendid and famous reports coming from the Smithsonian Institution. This is an exceedingly interesting one, and the subjects which have been investigated are of more than ordinary interest. Space will not permit the mention of more than a very few, and we hesitate even to enumerate these few, fearing that we may be showing partiality. Among the important articles are such as these: "The Earth and Sun as Magnets," by Geo. E. Hale; "The Earth's Magnetism," by E. Bauer; "Transmission of Energy," by Elihu Thompson; "Formation of Leaf Mold," by James Covill; "The Value of Birds to Man," by James Buckland; "The most Ancient Skeletal Remains," By Aleš Herdicka; "Flameless Combustion," by Carleton Ellis. These are among other subjects of equal interest and importance.

The half-tones, of which there are a great number, are of especial interest and are exceedingly well executed.

This is a book that ought to be read and studied by every person interested in science.

There is also in the book a splendid index of fourteen pages.

C. H. S.

Optical Projection, by Simon Henry Gate and Henry Phelps Gage, Cornell University. Pages ix+731. 16x22.5 cm. Cloth. 1914. \$3.00. Comstock Pub. Co., Ithaca, N. Y.

This remarkably interesting book, which has only recently come from the press, is one which will fill a place which work on projection has created for it. It is an unusual book in all of its features, and it is one which all instructors who have anything to do with projection apparatus in any phase of the work, should possess. It gives full information on this particular topic on any point which may arise in teaching. Space will not permit of an extended review of the book, but the writer has nothing but words of the highest praise to say concerning it. It is an authority on the subject.

An idea of the work may be secured from the following heads of the fifteen chapters: Magic Lantern and Direct Current; Magic Lantern and Alternating Current; Magic Lantern for Use on the House Electric Lighting System; Magic Lantern With the Lime Light; Magic Lantern with the Petroleum Lamp, with Gas, Acetylene and Alcohol Lamps; Magic Lantern with Sun-Light Heliostats; Projection of Images of Opaque Objects; Preparation of Lantern Slides; The Projection Microscope; Drawing and Photography with Projection Apparatus; Moving Pictures; Projection Rooms and Screens; Electric Currents and Their Meaning; Arc Lamps, Wiring and Control; Candle Power of Arc Lamps for Projection; Optics of Projection; and Uses of Projection in Physics—Normal and Defective Vision.

There are 413 cuts, half-tones, and illustrations, all well executed. The half-tones show different kinds and styles of lamps, lanterns, and moving picture apparatus. The black and white line drawings are splendidly executed, and the photographs of arc lamps in commission are finely made.

The subject of each major paragraph is given in the first sentence, which is printed in bold-faced type. There is an appendix with a very complete list of dealers in optical and projection apparatus. There is also a splendid bibliography. The book is printed on calendered paper, and is put up in a very attractive form.

C. H. S.

An Introduction to Laboratory Physics, by Lucius Tuttle, Jefferson Medical College, Philadelphia, Pa. Pages ix+150. 12.5x18.5 cm. Cloth. 1915. Jefferson Laboratory of Physics, Publishers.

This is a manual gotten out primarily for the use of medical students. It can, however, be used by others. It is a revision of mimeographed direction sheets which have been used in the Jefferson Medical College Physics Laboratory. The subject matter is presented in fifteen chapters, the work being differentiated in each. The method of procedure and directions for work have been given in considerable detail. Once placed in the pupil's hands, he will be able to carry out his work without very much outside assistance, if he has average intelligence. There is a table of logarithms, and a complete index. Mechanically, the book is well made, and of a convenient size for the student to carry in his coat pocket. C. H. S.

Vocational Mathematics, by William H. Dooley, Principal of Technical High School, Fall River, Mass. Pages viii+341. 13.5x19 cm. 1915. D. C. Heath & Company, Boston.

The experience of the author in organizing and conducting intermediate and secondary technical schools has made possible this textbook which has the real flavor of vocational mathematics, and still presents the subject-matter in a way that makes it possible to use it with great advantage in any secondary school. Given a teacher who realizes the importance of training pupils so that they may readily apply the principles of mathematics to the daily needs of manufacturing life and he can select from the abundance of material in this book parts suited to the needs of his pupils.

There are ten parts: Review of Arithmetic; Carpentering and Building; Sheet Metal Work; Bolts, Screws and Rivets; Shafts, Pulleys and Gears; Plumbing and Hydraulics; Steam Engineering; Electrical Work; Mathematics for Machinists; Textile Calculations. In the appendix are tables of logarithms and angle-functions, but throughout the book the work is nearly all arithmetical. The shop terms and processes, machines and instruments, and so on, that furnish the problem material are carefully explained and illustrated so that there should be no difficulty in the boy's understanding the work, especially if the teacher provides models, instruments and bolts, screws, and the like from the shops and laboratories.

H. E. C.

The Elements of Geometry, by W. N. Bush, Principal of the Polytechnic High School, San Francisco, and J. B. Clarke, Department of Mathematics of the same school. Pages xi+355. 14x19.5 cm. 1915. \$1.25. Silver, Burdett & Company, New York.

The authors call attention to the following special features of their work: *First*—The classification of definitions and axioms. *Second*—The arrangement into twenty-six groups of theorems relating to the same topic. *Third*—Exercises graded as to difficulty, and attached to groups of theorems upon which their solution depends. *Fourth*—Proofs of Theorems not essential to a clear understanding of geometry not given, left as exercises. *Fifth*—Compactness of each group. *Sixth*—Helpful suggestions in solving original exercises. *Seventh*—A simple statement, with illustrations, of the close connection between algebra and geometry.

This book will be of especial interest to teachers who wish to teach pure geometry, making no connections with other branches of mathematics nor with any other affairs in which the pupils are or may be interested. The grouping of related subjects and giving a large number of exercises on each group will no doubt aid pupils in acquiring ability to solve original exercises. The total number of exercises is large, 154 in plane geometry and 318 in solid geometry.

H. E. C.

General Physics for College Students, J. A. Culler, Miami University. 10+321 pages. 15x22 cm. Cloth. 1914. J. B. Lippincott Co., Philadelphia.

This is the latest college text on this subject, and it is one of the best. Only electricity, electro-magnetic waves, and sound, are discussed in this volume. The author has endeavored to use such language in the text that the average student will have no difficulty in understanding it. The most of the 217 figures are new, and all are very clear in their construction. The practical physical side of physics, with its applications, is emphasized. The electronic and electro-magnetic theories of matter are splendidly discussed. There are thirteen chapters in the book, and most of the general subjects that are taken up in college classes are mentioned. The type is large, and the paper is not highly calendered, thus the glaring reflection of light is not present to the reader. The book represents a life-long study in the field of physics by the author. It is worthy of a wide circulation, and doubtless will have it.

C. H. S.

A Review of Algebra, by R. H. Rivenburg, Head of the Department of Mathematics, The Peddie Institute, Hightstown, N. J. Pages 80. 13x19 cm. 1915. American Book Company, New York.

This collection of problems covers the ground of high school algebra, and is planned for use in the last year to give a thorough review for college entrance examinations and effective work in freshman mathematics in college. In the first pages the general outline gives all the terms to be defined, laws, processes and so on; and twenty college entrance examination papers are given at the end. The selection of problems seems to be well made; the advantages of a book like this for an effective review are apparent.

H. E. C.

The Evolution of Sex in Plants, by John M. Coulter. Pages i+140. 12.5x16 cm. 1914. \$1.00 net. Univ. of Chicago Press.

This is the first book of a "Science Series" which has been announced. It is promised that the volumes of the series "will present the complete results of an experiment or series of investigations" but will confine themselves to "specific problems of current interest, presenting the subject . . . with as little technical detail as is consistent with sound methods." "They will be written not only for the specialist but also for the educated layman." If later volumes attain the excellence of the first one the success of the series should be assured.

As a summary of our present knowledge and ideas on the subject, there is nothing comparable with it in the English language so far as the reviewer is aware. To have gathered the facts regarding the evolution of sex from their many original sources and embodied them in an available monograph would have been a distinct service; to make these facts an inspiration is an achievement which demands the gratitude of students and teachers. In this little book the high school teacher will find the principles and ideas by which his teaching on this subject must be checked, and these ideas are backed by all the facts that are necessary but not buried in the greatest mass of details that often obscures really important matters.

While the book is of particular interest to the teachers, so far as the secondary school is concerned, it can be recommended to the more mature and interested pupil's who have had some training in botany. The non-botanical science teacher who wishes to keep in touch with other sciences than his own will find it a very welcome presentation of the essentials in the field which it covers.

W. L. E.

Advanced Theory of Electricity and Magnetism, by Wm. S. Franklin and Barry Macnutt, Lehigh University. Pages vii+300. Cloth. 1915. \$2.00 net. The Macmillan Co., New York.

A text which bears out the high character of the authors', as writers of books on all phases of physics. The method of treatment is new and interesting. It is put up in such a way as to keep the student who uses it, continually thinking. It is a book for colleges and technical schools. Its statements are clear, concise, and in every respect true. The cuts, of which there are 217, are clearly drawn, and accurately illustrate the points in question. The major paragraphs begin with bold face type, and the first sentence is really the subject of the matter discussed under that particular paragraph. There are ten chapters. It is a book which should be in the hands of every student of advanced physics. C. H. S.

Stories of Old Greece and Rome, by Emilie Kip Baker. Pages xii+382. 13.5x19.5 cm. Cloth. 1913. \$1.50. The Macmillan Co., New York.

This work, because of its clear, distinct type, has an attractive look, even to the casual observer. From the very first line of the story, "In the Beginning," where the mind of the reader is carried back to "the days of long, long ago," to the closing chapter of the book, "The Apple of Discord," which so vividly depicts the remorse of a selfish nature, there is no diminishing of interest.

Emilie Kip Baker's *Stories of Old Greece and Rome* is invaluable not only as a text-book for classical students, but for all lovers of literature and "the aesthetic," as well as a pleasant companion for the mother in her story hour.

Its diction is pure and simple. Its simplicity of language in story telling takes from it the ever dreaded thought of the student, "the class room" and "recitation," while the ever-flowing rhythm of the ancient's nature and soil seem to pervade the simplest narration and bring to the reader the real fascination of Greek lore and Latin symmetry.

Not least among its attractions are the references in the appendix, by means of which one is made familiar with the most important translations of these myths by our great poets and authors. The reader finds himself unconsciously delving into the ancient and almost forgotten lore of other mythologists, who treat and ascribe to these same deities and muses various functions and duties. He sees the sacred rites of gods and goddesses through the eyes of the medieval and modern poets, stern Aeschylus, sympathetic Shelley, Longfellow, Elizabeth Barrett Browning, Rosetti, Fletcher, Keats, Landor, Tennyson, and many others with whose works the average reader would not become very familiar were it not for the most fascinating way with which the author fairly courts investigation. Likewise he is allured into reviewing Hawthorne's "*Wonder-Book*" that he may again hear the story of Pandora, or into reading Shakespeare's "*Midsummer Night's Dream*" that he may more clearly see how that great mind burlesques the story of Pyramus and Thisbe. The book is also invaluable as a guide in locating the works of great artists, who have put into clay, stone, or marble, or upon canvas, their translation of these much loved myths.

Every library, public or private, should include this valuable work of Emilie Kip Baker, a history, novel, reference book of literary comparisons, and a guide of art treasures, all in one. Old and young alike can enjoy this very interesting and instructive work. Complete in every detail, broad in its scope, "Ancients and Moderns" live side by side and speak face to face.

Mrs. C. H. S.

Text Book on Wireless Telegraphy, by Rupert Stanley, Queen's University, Belfast. Pages xiii+344. 15x22.5 cm. Cloth. 1914. \$2.25 net. Longmans, Green & Co., New York City.

Of the several texts on Wireless Telegraphy which the writer has had the privilege of reading and reviewing, he must say that this is one of the very best and most complete. The method of presenting the matter is new, interesting, progressive and thoroughly up-to-date. The text embodies all of the newest inventions and thoughts on the subject. It is written in such a manner that the student will be attracted to it.

There are 22 chapters, covering 305 pages, and 4 appendices, covering 40 pages. In the text are 201 illustrations. Too much cannot be said in praise of these. Nearly all, if not all of them, are new and original, and are drawn and presented in such an admirable way as to express at once the thought of the author. Mechanically, the drawings are as nearly perfect as it is possible for drawings to be made. There are many half-tones of wireless apparatus scattered through the book, which show judgment in their selection. At the close of most of the chapters are given questions and exercises bearing on the work discussed. The physics of the book is correct.

It will be an authority on wireless telegraphy; and it should be extensively used as a text on the subject. C. H. S.

"Chemistry of Common Things," by Raymond B. Brownlee, Robt. W. Fuller, Wm. J. Hancock and Jesse E. Whitsit, all of New York City. Pages viii+616. 14x19.5x3 cm. Profusely illustrated. Cloth. 1914. \$1.25. Allyn and Bacon.

This text is frankly designed to give a vast amount of information to boys and girls, who would probably never get it in any other way. The 600 pages are crowded with interesting facts, which are more or less related to chemistry.

The chapters on stoves and furnaces, on gas burners of various types and on oil and gas lights are especially interesting and contain many valuable practical applications of chemistry. Such a book as this ought to be available in every chemistry department, even where a more systematic text is used, for it will afford many valuable practical applications to enrich the teaching of the fundamental principles of chemistry.

The first 21 chapters of the book make up Part I, and in these chapters some attempt is made to teach the underlying principles of the science, although naturally this cannot be done as thoroughly as in the "First Principles of Chemistry," by the same authors.

The remaining 25 chapters take up applications of chemistry and afford much interesting material, which will be especially valuable for reference work to those classes which cannot visit real industries to see processes in actual operation.

The summaries at the ends of the chapters afford condensed accounts of the chief features of the chapters which they follow. Exercises and questions also follow the chapters.

While it is probably true that the authors are prouder of their "First Principles of Chemistry" as a means of teaching chemistry and also as a means of training boys and girls in thinking, it is nevertheless true that there is some legitimate place for a text of the sort of this new "Chemistry of Common Things," and there is certainly a popular demand for this sort of thing at present. For those who think the public is right in its insistence on the immediately useful this new text is one of the best the reviewer has seen.

F. B. W.

Education Through Play, by Henry S. Curtis, Lecturer on Recreation and Other Social Topics. Pages xix+355. 14x20 cm. Cloth. 1915. The Macmillan Co., New York City.

A book which treats of a phase of education which, if it had been advocated by an educator twenty-five years ago, would have subjected him to criticism such that a commission might have been appointed to investigate his sanity. It is a book which advocates and discusses getting into real touch and sympathy with the child, which emphasizes the bringing into school life those activities which go to make him feel that the school is more like a picnic than a prison. This is a book which will assist every teacher in the art of getting into complete sympathy with the pupils. It encourages the instruction of the child through activities of a nature such as children love to engage in. It is full of the theory of play.

The book is splendidly written in a fascinating and interesting style, and even the ordinary layman would be interested in reading it. There are sixteen chapters besides an extensive appendix. The major paragraphs begin with a sentence in bold-faced type which contains the core of the chapter's subject matter. There are printed in the volume nineteen well executed half-tones, mostly of children engaged in some out-door activity. Nothing but words of commendation can be said of this volume. Reader, send to the publishers immediately for a copy. C. H. S.

Our Knowledge of the External World as a Field for Scientific Method in Philosophy, by Bertrand Russell, M. A., F. R. S., Lecturer and Late Fellow of Trinity College, Cambridge. Pages ix+245. 15x23 cm. \$2.00. 1914. The Open Court Publishing Company, Chicago.

The eight lectures included in this volume, which were delivered as Lowell Lectures in Boston, in March and April, 1914, are an attempt to show by means of examples, the nature, capacity, and limitations of the logical-analytic method in philosophy. The central problem by which the author seeks to illustrate method is the problem of the relation between the crude data of sense and the space, time, and matter of mathematical physics.

Lecture I, Current Tendencies, discusses the three principal types of present-day philosophy: (1) The classical tradition; (2) Evolutionism; (3) "Logical atomism," so-called by the author, which is the type that he advocates.

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Lecture III, On our Knowledge of the External World, the author says that this discussion does not amount to an answer of a definite and dogmatic kind, but is only an analysis and statement of the questions involved, with an indication of the direction in which evidence may be sought.

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Lecture VIII, On the Notion of Cause, with Applications to the Free-Will Problem.

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The Beginner's Garden Book, by Allen French. Pages viii+392. Many live diagrams and illustrations. \$1.25. 1914. Macmillan Co.

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Plant Geography, An Introduction To, by M. E. Hardy. Pages 189. 66 cuts, maps and diagrams. 35 chapters. 1913. Clarendon Press at Oxford, England.

This text organizes the material of plant geography. It is a simple and clear treatment of the relationship between vegetation and occupations, the main vegetations of the earth, and a plant survey of the continents. It is an aid to the interpretation of the vegetation maps in the Oxford Wall series. The text has clear and simple maps of the plant regions of all the continents save Europe which is a serious omission, for the maps are better than the accompanying description which is often meagre and unsatisfactory to the pupil. The value of such a text might be greater if less space was devoted to main vegetations of the globe and more attention given to each continent. W. M. G.

The High School, Its Function, Organization and Administration, by John E. Stout, Cornell College, Iowa. Pages xxiii+322. 14x19 cm. Cloth. 1914. \$1.50. D. C. Heath & Co., Boston.

The author of this book has shown remarkable cleverness in presenting the American High School to the public, from many points of view. He has discussed the subject according to the recent changes in the social and educational conditions in the country. He has opened up fields of thought, and has presented new schemes for the proper governing and management of the High School which cannot but meet with the approbation of all intelligent readers and people who have been trying to get in touch with the secondary school system of the United States. The author discusses both the academic and vocational sides of the question and emphasizes the fact that the High School is the people's college and the place where the key to the highest possible efficiency in our country is to be found. Notwithstanding the fact that in some localities the High School is criticised, it is true that the influence which it wields with its young life is making itself felt in every corner of the nation.

The author devotes considerable space to the discussion of the curriculum, taking up in more or less detail the various studies. The book is one which all High School teachers should possess and read and study. It is one of the best books on the subject, printed. There are twenty-three chapters, and in the contents a synopsis of each chapter is printed. On the outside margin of each page is given in bold-faced type, at the beginning of each major paragraph, the key to the discussion in that particular paragraph. There is an index of four pages. The volume is printed on uncalendared paper, in large, clear type, and is written in an interesting and attractive manner, and is a book which deserves and doubtless will have a wide and extensive circulation. C. H. S.

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Der Untergang der Welt und der Erde, by Prof. Dr. M. B. Weinstein. Pages v+107. 12x18 cm. Price M. \$1.25. 1914. B. G. Teubner, Leipzig, Germany.

The first part of this little volume, No. 470 of the series "Aus Natur und Geisteswelt," presents the various ideas of the end of the world revealed in legends and myths, while the second part gives a review of the theories and speculations of astronomers, geologists, physicists and philosophers.

H. E. C.

Industrial History of the American People, by J. R. H. Moore. Pages vii+439. 75 cuts and maps, 13 chapters, index and a Teachers' Manual. Macmillan Co.

The book succeeds in emphasizing the industrial aspect of history and it is organized so that it can be used with high school students. The author's idea that the welfare of a community depends upon its industries, a knowledge of which is more important for students than Greek or Roman history, is refreshing to those interested in reorganization of the long accepted standards of high school instruction. The control of the growth and development of the nation by its industrial development at different periods is shown by the consideration of typical industries. The fisheries and explorations, the lumber and settlements, the fur trade and interior explorations and trade, the problems of labor and slavery, agriculture as a basis for the growth of the nation, manufacturing and transportation. The material is carefully organized and well adapted to high school pupils.

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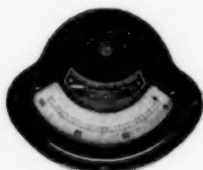
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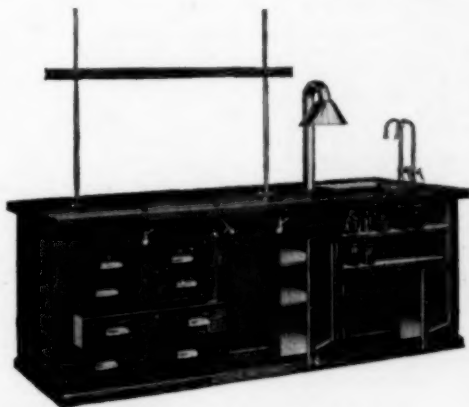
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